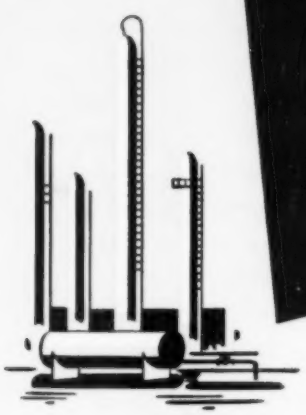
MAY, 1953

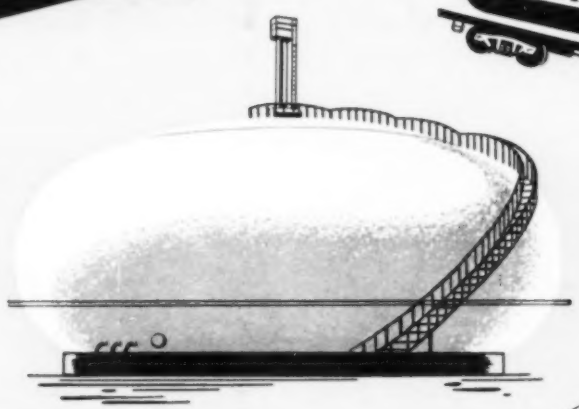
A New Feature—
Petrochemical
Reactions

# PETROLEUM REFINER

Specialized for Refining, Natural Gasoline, Petrochemical Engineering, Operations and Management.

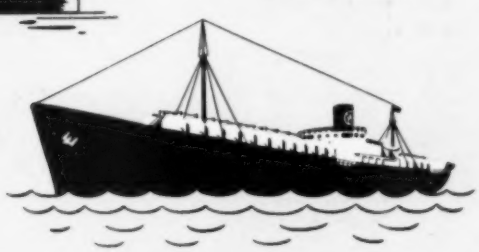



Service



NATURAL GASOLINE
PROPANE
ISO-BUTANE
BUTANE
ISO-PENTANE

NORMAL PENTANE
HEXANE
HEPTANE
HEAVY NAPHTHA
STA-VOL-ENE



WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

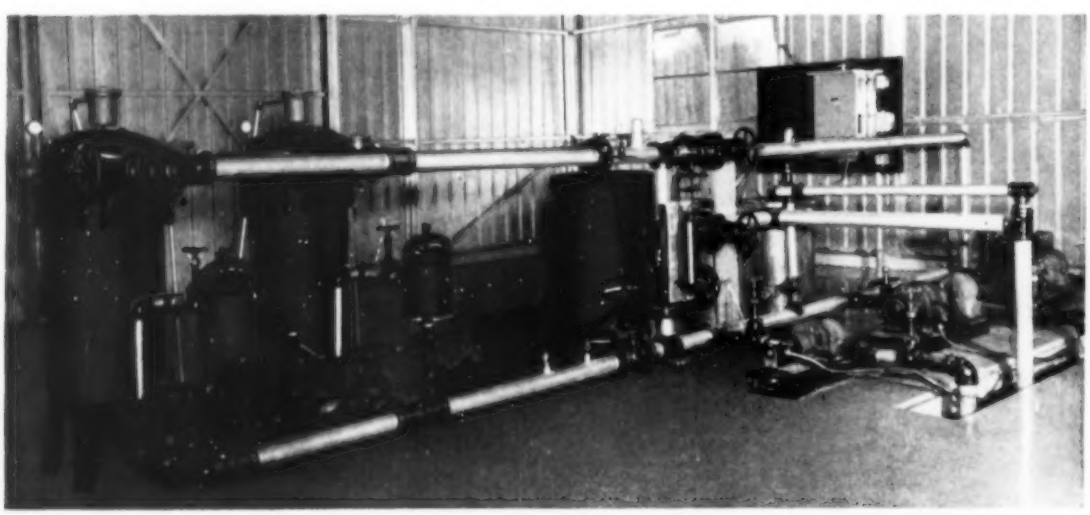
EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARREN DAS, HOUSTON, TEXAS

# TREAT FLOOD WATERS *Scientifically-*

**For Maximum Secondary Recovery!**

- REDUCE PUMPING COSTS
- BOOST PRODUCTION RATES
- INCREASE THE PROFITABLE LIFE OF YOUR LEASES

Don't let your oil sands become clogged with bacterial slime, algae, iron or other solids. Flood waters treated and filtered by %Proportioneers% Chemical Feeders and Pur-O-Cel Diatomite Filters are *right* for deep penetration and produce a maximum yield from your oil sands. %Proportioneers, Inc.% offers you field tested equipment and the services of its experienced engineering staff in cooperating with your water purification consultant to give you the most economical answer to your water-flood problems. For recommendations and descriptive bulletins, contact our nearest representative or write giving us the story of your present water treatment, an analysis of your water, and other pertinent information. Bulletin RP-9373 on request.



**See us at Booths 83-85 at the Oil Show in Tulsa**

% PROPORTIONEERS, INC. %

Write to %PROPORTIONEERS, INC.%, 412 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

# PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

Volume 32, No. 5 May, 1953


## API REFINING ISSUE


**How Feed Stock and Severity Affect Houdriforming Economics** ..... 113
H. D. Noll, T. A. Burtis and J. C. Dart

**TCP Process Offers These Advantages** ..... 117
L. P. Evans, K. E. Magin, J. I. Savoca and H. W. Shea

**Explosion-Proof Equipment Is Here to Stay** ..... 123
R. P. Northup

**Are You Lubricating Motors Properly?** ..... 127
Frank H. Walker, Jr., and William J. O'Meara

**How Serious Is Graphitization?** ..... 132
R. J. Fierentino and A. M. Hall

**New Shell Hydrodesulfurization Process Shows These Features** ..... 137
H. Hoog, H. G. Klinkert and A. Schaafsma


## OTHER TECHNICAL FEATURES


**Synthetic Organic Chemical in 1975** ..... 93

**Roosevelt Oil Has First Platreater** ..... 142

**Petroleum as a Raw Material for the Chemical Industry** ..... 143
Lewis F. Hatch

**Grace Chemical Venture Based on Three Processes** ..... 146

**Learning How to Use Dimensional Analysis, Part II** ..... 147
I. H. Silberberg and J. J. McKetta, Jr.

**What Acetylene Costs** ..... 151
T. Weaver

**A New Approach to Tray Design** ..... 157
Aksel C. Eld

**What Is "NPSH"?** ..... 162
Dan R. Rankin

**Taking Stock** ..... 166
Cecil W. Smith

**New Correlation for Total Pressure of Binary Systems** ..... 167
Roger Gilmont, Theodore Roszkowski and Donald F. Othmer

**A Simple Chart for the Vapor Pressure of Water** ..... 173
Kenneth A. Kobe

**Thermal Stresses in Piping Systems, Part III** ..... 174
William E. Wilbur

**The Viscosity, Thermal Conductivity and Specific Heat of Steam at Elevated Pressures and Temperature** ..... 179
Irving Granet and Philip Kass


### As Management Sees It


**Industry Should Boast of Great Fire Record** ..... 209
Franklin G. Wilson

**Let Supervisors Participate** ..... 217
F. E. Mathews

**This Actually Happened** ..... 221

**Improved Safety Record a Factor in Possible Insurance Rate Cut** 221


## DEPARTMENTS


| | | | |
|---|---|---|---|
| Quick Look | 2-3 | What's New in Manufacturers' Literature | Insert 192-193 |
| Letters | 87 | What's New in Equipment | 193 |
| Look Box | 89 | New Equipment Literature | 204 |
| Who's Building | 105 | How to Do It | 222 |
| Meet Our Authors | 182 | What's Happening in the Industry | 233 |
| Reviewing New Books | 190 | Who's Meeting | 267 |
| Here's More Information on Advertised Products | 192 | Calendar of Meetings | 268 |
| | | What Suppliers Are Doing | 270 |
| | | Index to Advertisers | 286 |



RAY L. DUDLEY, Publisher
A. L. BURNS, General Manager

DR. JOHN J. MCKETTA, JR., Editorial Director

ROBERT J. PHILLIPS, Editor
GEORGE B. GIBBS, Editor, Process and Construction
AL REESE, Editor, Special Assignments
CECIL W. SMITH, Economics Editor
ROBERT E. SPANN, Eastern and Foreign Editor
GILBERT M. WILSON, Western Editor
DR. LEWIS F. HATCH, Contributing Editor

SILAS B. RAGSDALE, Managing Editor
DAVID G. WILLIS, Editorial Assistant

Specialized Oil Publications of
THE GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the refining-natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing-pipe line industry

TOM W. NELSON, Advertising Manager

Advertising Representatives
GENE HART, GEORGE SKELTON, NELSON BIGELOW, 250 Park Ave., New York 17, N. Y.
H. G. FITZPATRICK, MARTIN HALLORAN, 332 S. Michigan Ave., Chicago 4, Ill.
J. W. CURTIS, W. W. Wilson Bldg., Huntington Park, Calif.
BILL WESTFALL, 1010 Euclid Ave., Cleveland 15, Ohio
BILL ATCHESON, Hunt Bldg., Tulsa 3, Okla.
CHARLES WYATT, CLAIR BRYAN, JR., 3301 Buffalo Drive, Houston 19, Texas
D. S. CRAIG, Mgr. Advertising Service Dept.

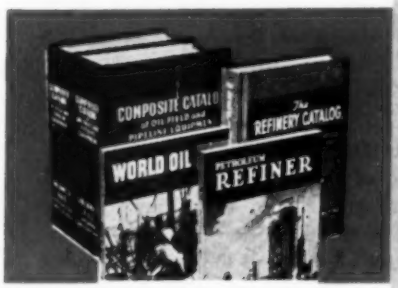
Circulation Department
R. M. DE SOMBRE, Manager
Box 2608, Houston, Texas

Single copies 50 cents (except special issues) for U. S. and Canada; $1 for all other countries. Subscription rates—U. S. and Canada $2 a year; Latin America and overseas $5 a year. PETROLEUM REFINER, published on the 15th of every month, entered as second class matter June 16, 1925, at the post office at Houston, Texas, under act March 3, 1879. Advertising rates on application.


Copyright 1953 by The Gulf Publishing Company.



Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Mich.

A Quick Look at

# PETROLEUM REFINER This Month

**Synthetic Organic Chemicals in 1975 . . .** To what level of production will synthetic organic chemicals rise by 1955 and by 1975? Such a question, seemingly unanswerable in view of the rapid production growth in the last ten years, must be faced by the industry because of petroleum's stake in raw materials. In this article you will find the Materials Policy Commission report organized into tables which give the answer to this question. These tables also include ratios of the yearly figures. **Page 93.**

**How Feed Stock and Severity Affect Houdriforming Economics . . .** This article fills an important need in catalytic reforming literature. It illustrates the economic selection of charge-stock boiling range and severity for the Houdriforming of a typical sweet naphtha. It concludes that it is best to reform to a moderate severity the lowest octane-number component of the straight-run naphtha. **Page 113.**

**TCP Process Offers These Advantages . . .** This new development in decolorizing lubricating oils and waxes can mean (1) lower investment costs than conventional static-bed percolation; and (2) lower operating costs than hot contacting. The Thermofor Continuous Percolation Process involves oil decolorizing and clay washing in a continuous counterflow system, clay drying, and regeneration in a clay-burning kiln. Conventional percolation clays are employed. No naphtha dilution is necessary on heavy stocks. Essential features of the process have been tested in pilot-scale equipment and proved in a 500 barrels per day demonstration plant. **Page 117.**

**Explosion-Proof Equipment is Here to Stay . . .** Every designer has been faced with the alternatives: shall I spend the money to eliminate the hazard, or is explosion-proof equipment the more economical route? In recent years, the choice has gone to the latter with increasing frequency. This article will give you the essentials in the design and application of explosion-proof equipment to help insure a wise choice. **Page 123.**

**Are You Lubricating Motors Properly? . . .** Measure your methods against the results of an exhaustive five-year test. For instance, the testers found that electrical motors shouldn't be lubricated more often than once each three years. In fact, under certain conditions, this period can be stretched to five years. They also learned that sealed bearing housings do the best job, that high quality grease is vitally important, and that the speed of the motor may be the tail that wags the dog. It's yours for the asking (or reading)—the complete results of a costly and thorough test program, beginning on **Page 127.**

**How Serious is Graphitization? . . .** Does it constitute a serious mechanical and operational hazard? If so, how bad is the danger, and what can be done about it? An API committee was appointed to find the answers to these questions. Here is the complete factual report of their extensive investigations. If you have high temperature equipment, as of course you do, then you cannot afford to let this important discussion escape your notice. **Page 132.**

**New Shell Hydrodesulfurization Process Shows These Features . . .** This is the answer to the problem of sulfur removal in the middle distillates. The process features the application of the trickle technique in which the feed stock is trickled in liquid form over a fixed bed catalyst. From 85 to 90 percent sulfur removal is accomplished with high-octane gasoline obtained as a by-product. **Page 137.**

**Understanding the Chemistry of Petrochemical Reactions . . .** Part I, which deals with petroleum as a raw material for the chemical industry, initiates this most informative series on the background of organic chemistry for the petrochemical industry. The author is Dr. Lewis F. Hatch, professor of chemistry, who teaches graduate courses in petrochemical processes. Not only will you mark this one for early reading, but you will want your friends to see it, too. **Page 143.**

**Learning How to Use Dimensional Analysis . . .** In the first article of this series you learned which dimensional system you should use. The next step is the correct use of the dimensional system you are using. Here are three examples of the correct usage of

## A Quick Look . . .

your system. A table of 24 of the most common variable quantities are given in all three of the primary dimensional systems. The importance of dimensional homogeneity is discussed and illustrated in detail. **Page 147.**

**What Acetylene Costs . . .** The bright future of acetylene as a chemical building block has prompted recent investigations into alternate routes of production. Now getting close scrutiny is the Wulff process utilizing light hydrocarbons as the starting point. In this article is presented cost data for two plant locations. Comparison with the carbide route to acetylene shows how attractive the Wulff process is in areas where low-cost natural gas, ethane or propane is available. **Page 151.**

**A New Approach to Tray Design . . .** A new equation for the design of fractionating trays, called the Jetting Equation, is presented here for the first time anywhere. Although the use of the relation is in the experimental stage, the author substantiates its validity with complete operating and design data. You will also profit from the factual comparison of the vapor capacity of perforated trays with the capacity of conventional bubble caps plates. The author takes the position that the perforated tray is highly superior in vapor capacity and offers proof. **Page 157.**

**What is "NPSH"? . . .** The term "net positive suction head" is widely used by engineers but the physical significance of the term is understood by only a few. It is always necessary in making proper application of engineering formulae to use the value of NPSH. What do people mean by "cavitation"? Have you ever seen strobotactic pictures of a pump during cavitation? Who else can tell you so authoritatively and so simply about this interesting and important phenomenon as Dan Rankin? Here are many illustrative cases in simple words. **Page 162.**

**New Correlation for Total Pressure of Binary Systems . . .** The results of this new correlation lead to the development of a generalized method for predicting total pressures of a paraffin binary system. The correlation is an extension of the well-known Othmer method for estimating vapor pressures. Applied to the lower paraffins, the method is based on comparing the total pressure of one binary system against a second as the standard. **Page 167.**

**A Simple Chart for the Vapor Pressure of Water . . .** Use this chart for rapid determinations. Use it as a conversion table as well as a data source. Put it into your notebook today. **Page 173.**

**Thermal Stresses in Piping Systems . . .** Part III concludes one of our most popular series. Aimed at giving the design engineer a practical workable handbook, this information on piping design has been tried and tested by one of the major construction companies and found to be reliable. The author's many years of design experience have been reduced to these simplified methods. Must reading for design engineers. Turn to **Page 171.**

**Viscosity, Thermal Conductivity and Specific Heat of Steam at Elevated Pressures and Temperatures . . .** These important physical properties are presented in time-saving graphical form. The most recent data are correlated in one convenient graph for each property. There has been a great discrepancy in the viscosity of steam at elevated pressures. Several investigators disagree widely and given here are the data believed to be the most accurate and representative. **Page 179.**

**Industry Should Boast of Great Fire Record . . .** Let's stand up and shout about a fire record almost without parallel in U. S. industry. The petroleum industry has an excellent fire record, but because so little is said about it, and because the few petroleum fires are sometimes so spectacular, the general public has the wrong idea. The author, Franklin G. Wilson, Director of Safety and Fire Protection for the API, believes that dissemination of the facts about the industry's fire record will relieve the fears of the public and do much toward improving public relations. **Page 209.**

**Let Supervisors Participate . . .** You can reduce accidents, improve efficiency, and advance public relations by making participation the key to your supervisor cooperation program. The Casper refinery of Standard Oil Company (Indiana) used this method to augment, in effect, its one-many safety department with a supervisory force of 70. **Page 217.**

**This Actually Happened! . . .** Carelessness, not hazards, causes most accidents. Everybody knows this; few remember it. This is the first of a series of pictorial safety messages taken directly from the records of companies in the industry. Only the names of the persons and firms are omitted. We invite you to clip them. Put them on your bulletin board. Pound home the warning that it's easy to get hurt! Don't miss **Page 221!**

# Making water work harder

Water alone won't work—it takes *soap* to get Butch really clean!

As recently as a century ago, families made their own soap by boiling kitchen fats with lye they extracted from wood ashes. But since 1837 chemical discoveries as to the nature of fats, glycerin, and alkali have transformed soap-making from a household handicraft into a giant process industry. Today this industry is making water work harder than ever with new synthetic detergents of greater wetting and emulsifying power—even in hard water or acid solutions where soaps won't work.

As a matter of fact, 40% of the cleaning agents now in use are synthetic detergents. Over half of them are alkyl aryl sulfonates, known in practically every home in America by short trade names such as Fab*. They are made from a combination of sulphuric acid and benzene-like oils which is then neutralized to form the non-corrosive sulfonate. ALOYCO valves made of Aloyco 20 and Inconel are widely used by the three leading firms in the soap field, as well as by other processors of synthetic detergents to withstand the corrosiveness of the basic ingredients.

These harder working "soaps" represent only a small percentage of the many new end-products of modern chemistry that flow through ALOYCO corrosion-resistant valves during their processing. ALOYCO —in its engineering, its research and testing facilities, and in its manufacturing operations—has kept pace with the technical growth of the industries it serves. ALOYCO valves go hand-in-hand with chemical progress.

If your business involves chemical processing, the *Aloyco Corrosion Engineering Service* will be glad to assist you in selecting the proper valve and design for every corrosive service. Write to ALOYCO about your own valve needs. 3.13

*Registered Trade Mark of Colgate-Palmolive-Peet Company*

Longer Lasting
ALOYCO VALVES
1st in Corrosive Service

**ALLOY STEEL PRODUCTS CO., INC.**
1303 West Elizabeth Avenue, Linden, N. J.
Plants: Linden, N. J.; Bloomfield, N. J.; Elizabeth, N. J.

*DISTRICT OFFICES*

**NEW YORK 1, N. Y.**
350 Fifth Avenue

**ATLANTA, GEORGIA**
333 Candler Bldg

**HOUSTON 6, TEXAS**
K. E. Luger Co.
2716 Danville St.

**WILMINGTON, DEL.**
226 West Ninth St.

**ST. LOUIS, MISSOURI**
1221 Locust St

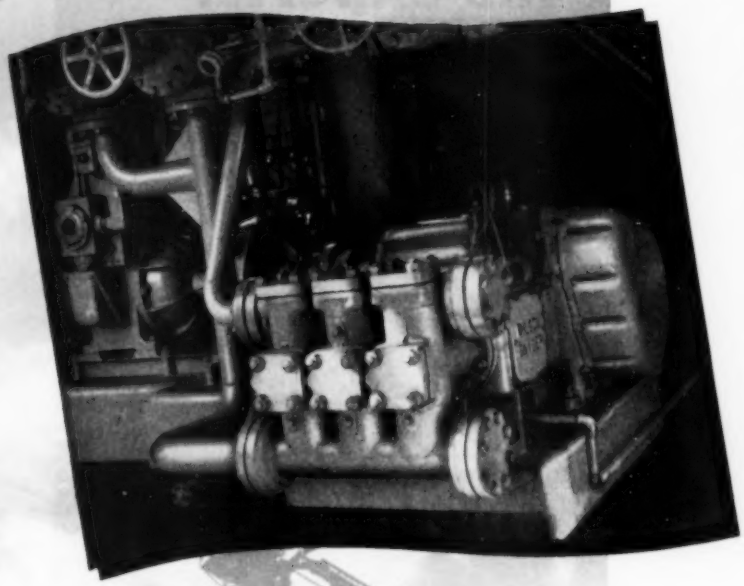
**SAN FRANCISCO, CALIF.**
24 California St.

**PITTSBURGH 22, PA.**
318 Investment Bldg.

**CHICAGO 4, ILL.**
332 So. Michigan Ave

**LOS ANGELES 22, CALIF.**
5442 Jillson St.

# "This Wilson-Snyder Triplex Pump



**is performing so well in Reactor Charge Service for our Platforming Unit at Grandfield, Oklahoma,**

## that we're using TWO MORE

## —in our Ben Franklin Refinery at Ardmore!"

*— says Dr. I. Arthur Anson*
*Vice President in Charge of Refining*
*Bell Oil and Gas Company*

*Bell Refinery, Grandfield, Oklahoma*

## —in Bell's Grandfield Refinery

. . . a Wilson-Snyder Triplex plunger pump, size 3¾" x 6", is the reactor charge pump for the U.O.P. designed platforming unit which went on stream in June, 1951.

This pump is equipped with hardened steel plungers (500 Brinell) and heat-treated and hardened drop-forged stainless steel valve service. It utilizes the output of a 50-hp. electric motor, through a gear reducer, to develop differential pressures of 800 to 900 p.s.i. through 4" intake and 3" discharge piping; handling hydrocarbons having a specific gravity of 0.67 at pumping temperatures of 275°F.

## —in the Ben Franklin Refinery at Ardmore

. . . two more Wilson-Snyder pumps of the same size and type will be used in the new "cat" unit. One of these pumps will serve as the fresh feed pump—the other as a recycle and quench pump.

***When You have pumping applications that demand reliable performance, contact "Oilwell's" nearest Refinery Specialist at Area office points shown below and get complete information on . . . WILSON-SNYDER REFINERY PUMPS.***

**OIL WELL SUPPLY**
**DIVISION**
**UNITED STATES STEEL CORPORATION**

Executive Offices—DALLAS, TEXAS
Export Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Area Offices— CALGARY, CANADA
CASPER, WYOMING . . . COLUMBUS, O.
DALLAS, TEXAS . . . HOUSTON, TEXAS
TULSA, OKLA. . . . LOS ANGELES, CALIF.

*Branches Serving All Oil Fields*

USS TRADE MARK

# "OILWELL"

TRADE MARK

UNITED STATES STEEL

# How to get the most for your tube steel dollar: Ask the experts!

*This month the Timken Company reports on:*

## 18-8 STAINLESS

**An austenitic, non-magnetic alloy that shows the best combination of creep strength, oil corrosion resistance and oxidation resistance for service up to 1500°F. For use in oil cracking systems, hydrogenation equipment, high temperature oil and steam piping, superheater elements, heat exchangers.**

**ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS**

| | | | |
|---|---|---|---|
| Carbon | Sicromo 2 | Sicromo 5S | 18-8 Ti |
| Carbon-Mo. | Sicromo 2½ | Sicromo 5MS | 16-13-3 |
| DM-2 | 2½% Cr.-1% Mo. | Sicromo 7 | 25-20* |
| Silmo | Sicromo 3 | Sicromo 9M | 25-12* |
| DM | 4-6% Cr.-Mo. | 18-8 Stainless | 35-15** |
| 2% Cr.-Mo. | 4-6% Cr.-Mo.-Ti. | 18-8 Cb | 16-25-6** |

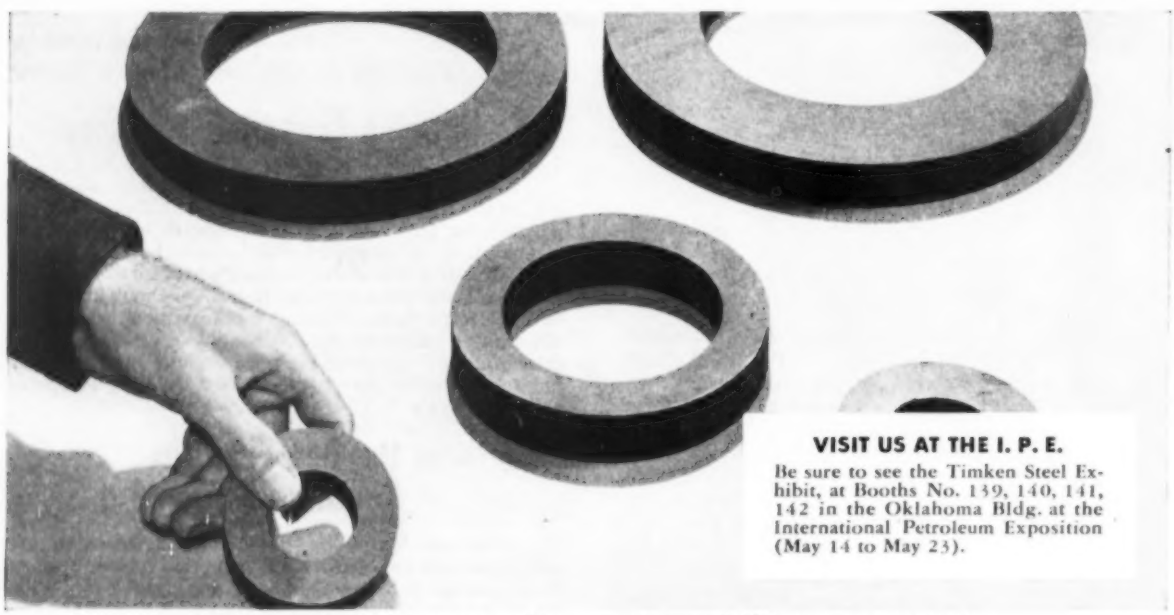
** Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

ALTHOUGH several high temperature steels may be the answer to your heat, pressure, corrosion and oxidation problems, there's only one analysis that will give you maximum tube life per dollar spent—the best life/cost ratio.

To find it, *ask the experts!*

The Timken Company's metallurgists — recognized authorities on high temperature steels, with over 20 years of steel research and experience—will help you select from 24 different analyses, the one steel that will give you the most for your money. And no matter which analysis you select, you'll be sure of uniform quality because the Timken Company rigidly controls quality from melt shop through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve your tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



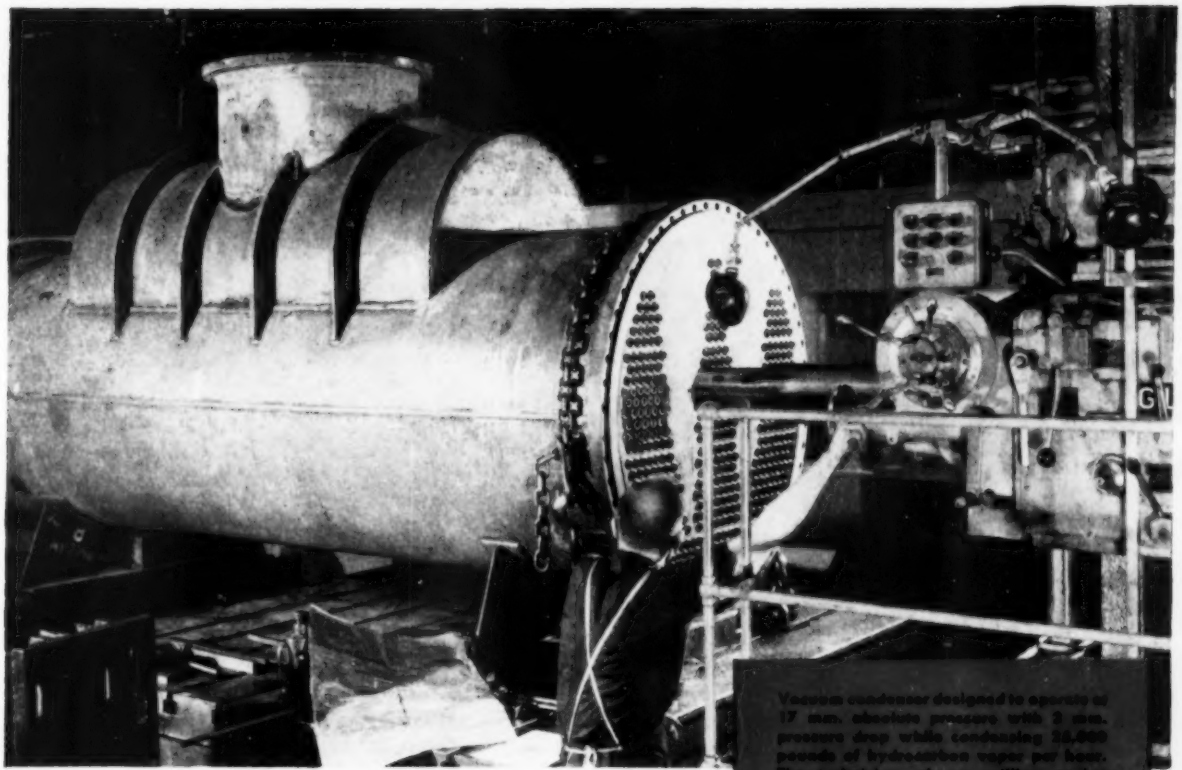
**VISIT US AT THE I. P. E.**

Be sure to see the Timken Steel Exhibit, at Booths No. 139, 140, 141, 142 in the Oklahoma Bldg. at the International Petroleum Exposition (May 14 to May 23).

*Typical examples of Timken heavy-wall pressure tubing—available in sizes up to 10½" O.D.*

**YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH**

**SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING**



Vacuum condenser designed to operate at 17 mm. absolute pressure with 2 mm. pressure drop while condensing 28,000 pounds of hydrocarbon vapor per hour. The technician, shown milling gasket grooves in the tube sheet, has been with A. O. Smith continuously since 1931.

# SPECIAL Heat Exchangers

## FOR CUSTOMERS' PROCESS REQUIREMENTS

**Shown nearing completion** is the A. O. Smith solution to one of its customer's heat exchanger problems. Starting with only the process conditions, the condenser was designed and manufactured in its entirety by A. O. Smith.

**Successful design** of the exchanger to meet critical process requirements necessitated a special tube arrangement to provide minimum pressure drop, and inlet nozzles to give maximum distribution of vapors throughout the entire length of the condenser.

**For the design** and manufacture of special equipment to solve special process conditions, like the above, A.O. Smith has a corps of experienced research, engineering and manufacturing groups. For over 25 years they have been serving the petroleum and chemical industries, accumulating invaluable experience, data and skills which *YOU* may depend on to help solve *YOUR* heat exchanger and vessel problems.

**A.O.Smith**

**VESSELS • HEAT EXCHANGERS**

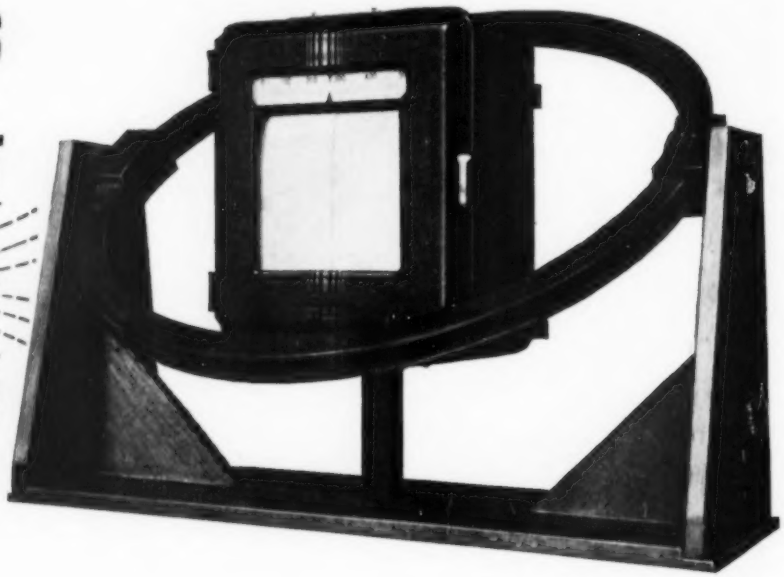
Chicago 4 • Cleveland 15 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 22 • Midland 5, Texas • New Orleans 12
New York 17 • Pittsburgh 19 • San Francisco 4
Seattle 1 • Tulsa 3 • Washington 6, D. C.
International Division: P.O. Box 2023, Milwaukee 1, Wis., U.S.A.

Research and Engineering Building

INDUSTRY COMES TO A. O. SMITH
WITH HEAT EXCHANGER PROBLEMS

# Speedomax is engineered for FIELD service

*Here's how L&N engineers verify Speedomax resistance to stray electrical fields. The ring is a Helmholtz coil, adjustable for a wide variety of field effects.*



● Built into every Speedomax recorder and controller is a high degree of indifference to stray electrical fields. And this is one of its most useful characteristics in almost any job. It means that you can install a Speedomax near a big motor, power line or X-Ray machine—any electrical equipment in fact—and you'll probably see no effect at all from surrounding electronic noise and "junk".

The reason for this indifference to stray fields goes back through the adjustment, building and design of the instrument, to its basic engineering. Speedomax has an *electronically-clean measuring circuit*, as well as clean signal and amplifier circuits.

This clean design includes a bifilar-effect slidewire, to eliminate any objectionable inductance at that point. It includes our "no-moving parts" trolley contact on the slidewire, which eliminates pigtails and their variable inductances. It includes use of a Mumetal slidewire shield where desirable, instead of less expensive but lower-permeability aluminum. And it includes a lot of just downright meticulous detailing, such as carefully engineered wiring and input filtering, plus ingenious shielding where required.

These and other precautions eliminate out-of-phase components in the supply to the amplifier. The latter therefore doesn't "load"; hence sends the correct amount of correct-phase power to the balancing motor. With ample power, the motor's recording and control action is snappy and accurate.

Our Catalog ND46(1) and Technical Publication ND46(1) tell the story. Write our nearest office or 4923 Stenton Avenue, Philadelphia 44, Pa.

*Chemical, pharmaceutical and petroleum engineers find that Speedomax instrument operation is not affected by the stray fields created by nearby motors, power lines, magnetic separators and the like.*

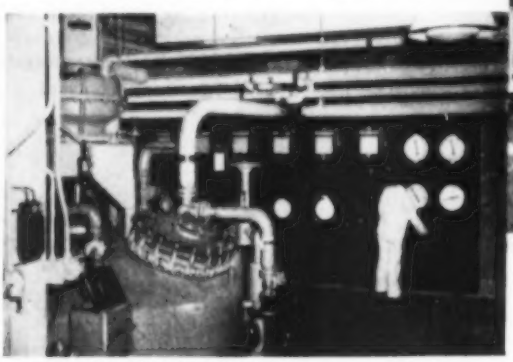


PHOTO COURTESY PARKE DAVIS & CO.

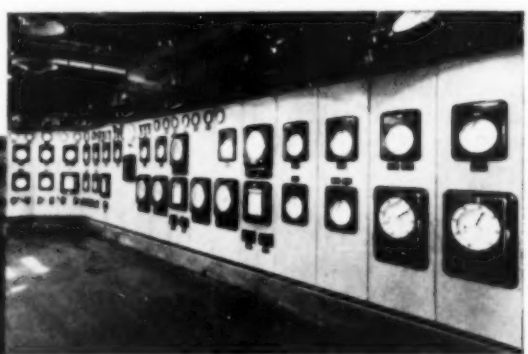


PHOTO COURTESY AN OIL REFINERY.

*Jrl Ad ND46(10c)*

LEEDS & NORTHRUP

instruments automatic controls • furnaces

# Where INSUL-MASTIC stands guard!

Moist, salty atmosphere makes the Gulf Coast of Texas the *Playground of Corrosion.* Here Refineries and Chemical Plants rely upon Insul-Mastic Coatings for protection against rust. From Brownsville to Lake Charles you will find tanks, towers, pipes, vessels and other equipment heavily sprayed with this *Superior* coating. Maintenance operations everywhere have been greatly reduced because INSUL-MASTIC's protection will last for many, many years.

Stopping moisture alone does not prevent corrosion here. Acid, alkali and other industrial vapors work hard to break down coatings and get at the metal beneath. That's why the very durable INSUL-MASTIC coatings are so extensively specified along the Gulf Coast. They are extremely resistant to chemicals as well as to moisture.

INSUL-MASTIC's record in *corrosion's playground* cannot be approached. There are many years and hundreds of jobs to prove its lasting protection. Specify INSUL-MASTIC to prevent corrosion.

*Insul-Mastic's record also includes vaporsealing thermal insulation. There's no better way to keep your insulation dry.*

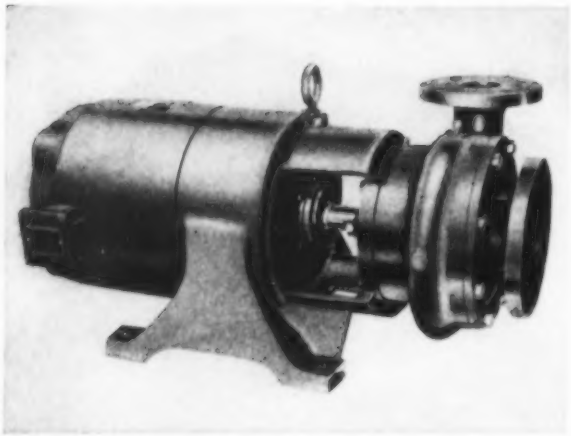
**Think First of the Coatings that Last!**

**Insul-Mastic**

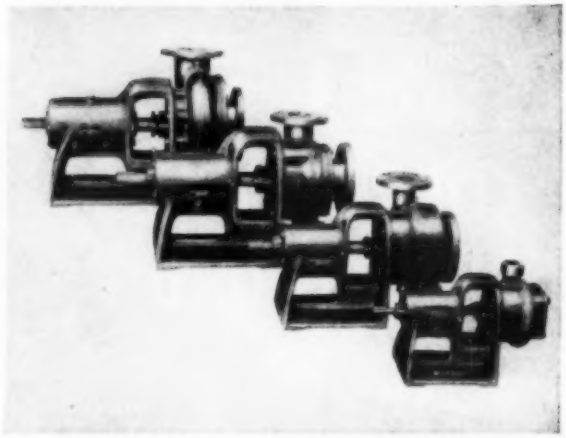
**CORPORATION OF AMERICA**

**Oliver Building • Pittsburgh 22, Pa.**

**Representatives in Principal Cities**

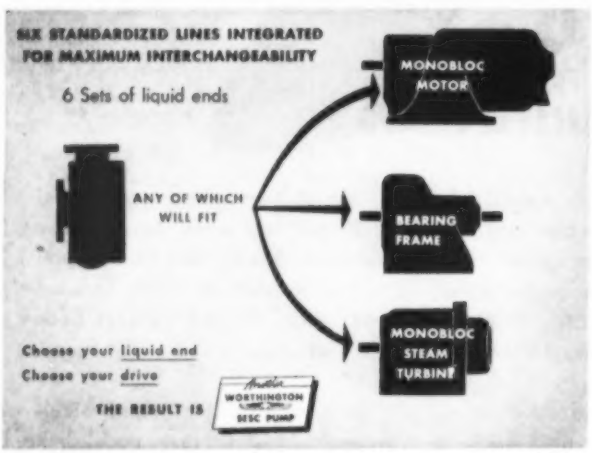


**WITH BUILT-IN MOTOR**—Well known throughout industry is this compact streamlined Worthington Monobloc centrifugal pump. Worthington SESC standardization makes it possible to interchange any of six sets of liquid ends to the motor housing.



**FOR ANY CONVENIENT DRIVE**—Frame-mounted units are available in four frame sizes. Like the Monoblocs, they use the same six sets of liquid ends and either conventional packing or a standardized mechanical seal that is readily changed in the field if necessary.

# Why Worthington's SESC* pump line means greater availability, broader selection, easier servicing




**STANDARDIZATION** of *parts*, *mountings*, *materials* and *dimensions* virtually eliminates the necessity of slow and expensive custom manufacture to meet special pumping requirements. From 650 parts within its six standardized sets of liquid ends, Worthington can assemble 60,000 *different* standard pumps! C.3.1

*Greater availability* because the new Worthington pump line will handle more requirements with a *standard*, readily obtainable unit.

*Broader selection* because of the complete range of ratings and special design features in the 60,000 different SESC pumps.

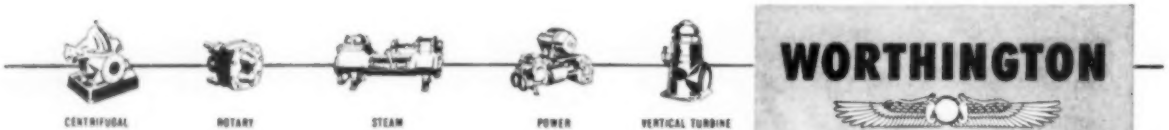
*Easier servicing* because standardized parts mean lower parts-inventory requirements.

This sums up the advantages you can expect when you use Worthington standardized centrifugal pumps. The SESC line is Worthington's latest move towards assuring you the *right* pump for the job.

For more information, contact your local Worthington distributor or write for Bulletin W300 B-4 to Worthington Corporation, Centrifugal Pump Division, Harrison, New Jersey.

*Standardized End Suction Centrifugal

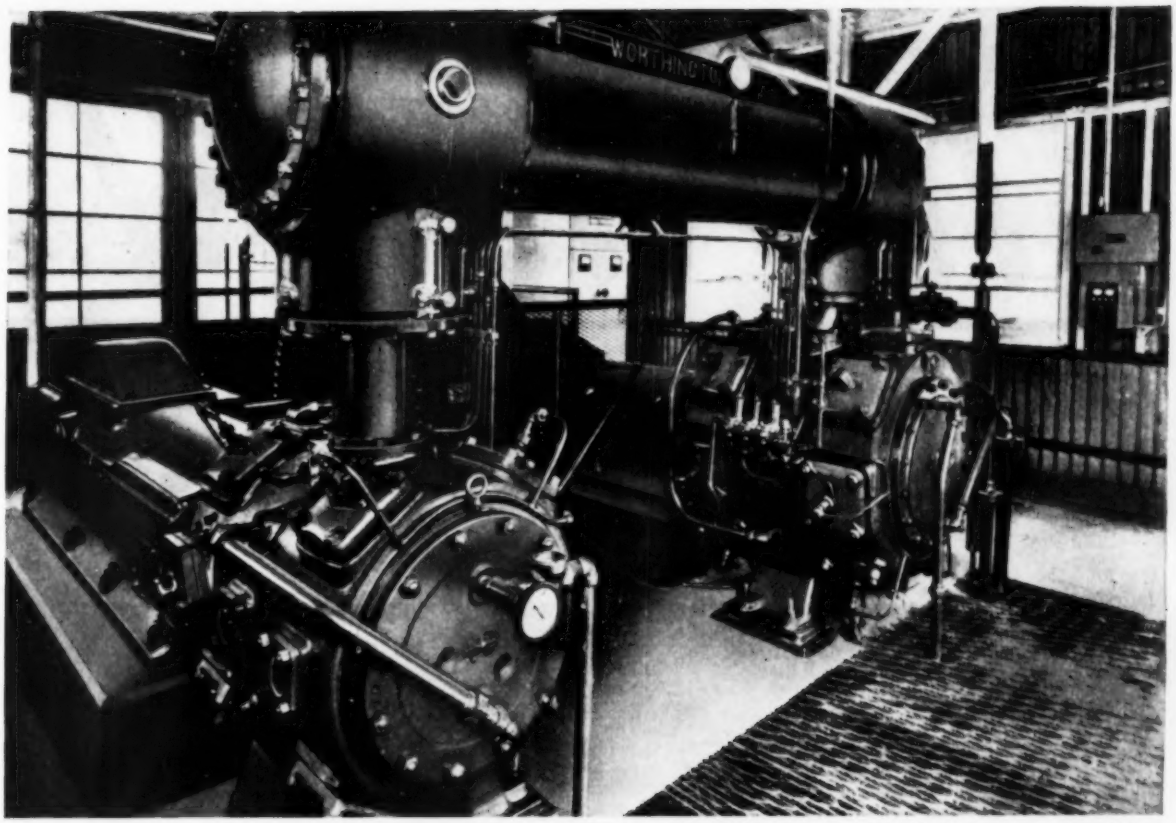
***Visit the Worthington Exhibit Building: corner Mid-Continent and Oklahoma Drives***




**The World's Broadest Line Assures You The Right Pump For Every Job**

**WORTHINGTON**

Centrifugal Pumps



**WORTHINGTON DC-2 HORIZONTAL AIR COMPRESSOR,** one of 14 Worthington compressors used for various services at the Girard Point, Pa., station of the Gulf Oil Company.

# THIS COMPRESSOR KEEPS PACE WITH VARIABLE LOADS

Like compressors in industry everywhere, this installation at a large eastern refinery must face many variable load problems. Unless properly handled, variable compressor loads often result in wasted power and high running costs.

Worthington Five-Step Variable Capacity Control solves this problem.

The by-pass regulation—as achieved by suction valve unloaders and clearance pocket unloaders—is exclusively Worthington and offers these important advantages:

**Economy of power**—the air required at any moment determines the power used.

**Simplicity**—inlet valves and unloading mechanism form one individual element, easily accessible.

**Low operating temperatures**—a cooler cylinder insures improved lubrication and low oil consumption.

This Type DC-2 compressor is also equipped with the exclusive Worthington Feather* Valve—the lightest and most efficient compressor valve available.

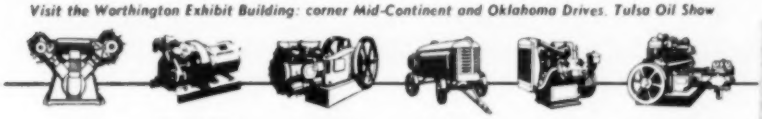
Write for air compressor bulletin L-675-B1B to your nearest Worthington district office or to Worthington Corporation, Compressor Division, Buffalo, New York.

*Reg. U. S. Pat. Off.

**A GLANCE AT THE INDICATOR PANEL** of the Worthington five-step governor shows operating capacity at any moment.

K.2.13

*Visit the Worthington Exhibit Building: corner Mid-Continent and Oklahoma Drives. Tulsa Oil Show*



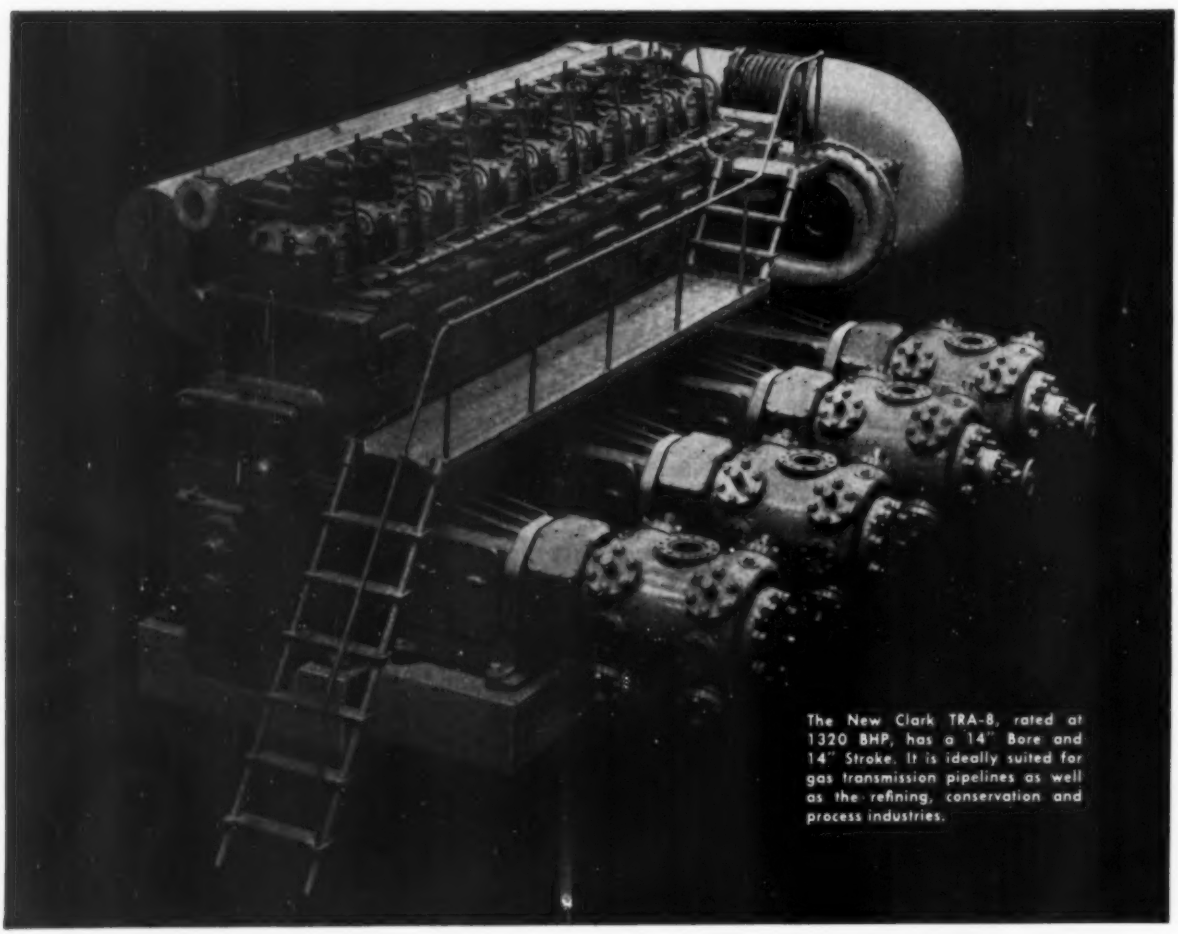

**No Other Compressor Will Outperform a Worthington**

**WORTHINGTON**

Compressors

# ITS HERE!

## The NEW Clark 2-Cycle



The New Clark TRA-8, rated at 1320 BHP, has a 14" Bore and 14" Stroke. It is ideally suited for gas transmission pipelines as well as the refining, conservation and process industries.

***Clark Continues to Set the Pace in Compressor Progress***

*revolutionary compressor development!*

# Turbo-Charged "Right Angle"

**It's here — after seven years of intensive development. Clark revolutionizes compressor design with the first 2-Cycle Turbo-Charged Gas Engine Driven Compressor . . . the TRA. Another Clark first! A precedent-shattering development that makes possible —**

### 50% MORE POWER

Developing 1320 bhp, the TRA-8 delivers 50% more power than any comparable compressor, with *no* encroachment on overload carrying ability.

### SHARPLY REDUCED FUEL CONSUMPTION

The TRA is conservatively rated *and guaranteed* to burn substantially less fuel than *any* gas engine driven compressor now built.

### 25% LESS COOLING WATER LOAD

(Including scavenging air intercooler load.) Vast amounts of waste heat are recovered from the exhaust gases by the Clark Turbo-Charger and are converted to useful work.

### FLAT FUEL CONSUMPTION CURVE

Fuel consumption remains practically constant over a wide range of load conditions.

### QUIET

Energy goes into power, rather than noise. Much quieter than a conventional gas engine driven compressor. No exhaust pulsations.

### UNPRECEDENTED RUGGEDNESS

Tremendous stamina, unapproached by any other compressor design. Conservative BMEP rating.

### COMPACT IN-LINE DESIGN

Very economical of floorspace, foundations and building requirements, yet highly accessible.

●

The Clark TLA, with 17″ bore and 19″ stroke, is also available when units of even greater horsepower than the TRA are required. For complete engineering details — the facts behind this revolutionary compressor development — see your nearest Clark representative and write for Bulletin 130.

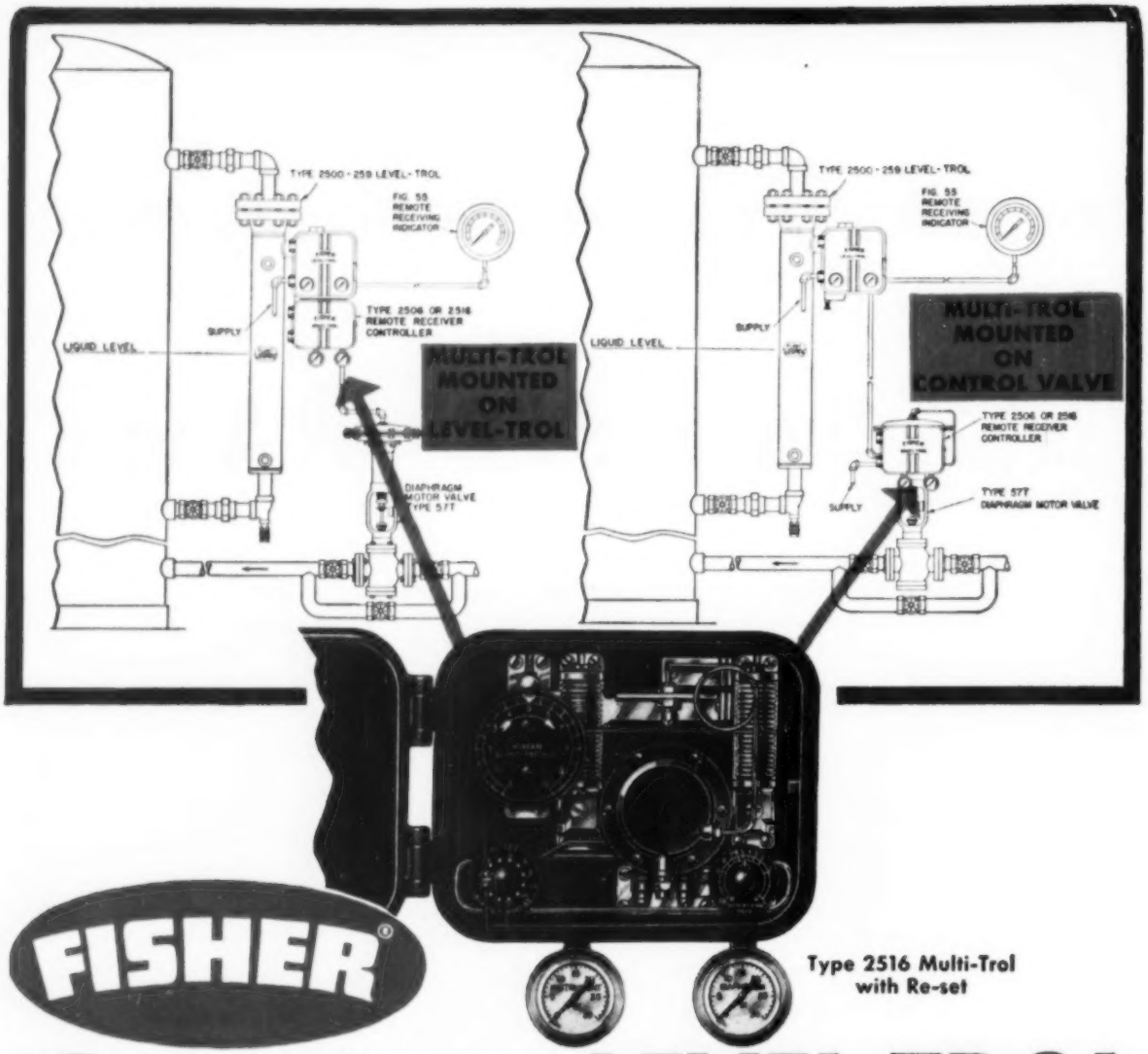
**CLARK BROS. CO. • OLEAN, N. Y.**

DIVISION OF DRESSER OPERATIONS, INC.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

**CLARK compressors**

© 1953, Clark Bros. Co., Division of Dresser Operations, Inc.


TYPE 2500 - 259 LEVEL - TROL
FIG. 55 REMOTE RECEIVING INDICATOR
TYPE 2506 OR 2516 REMOTE RECEIVER CONTROLLER
SUPPLY
LIQUID LEVEL
MULTI-TROL MOUNTED ON LEVEL-TROL
DIAPHRAGM MOTOR VALVE TYPE 57T
TYPE 2500 - 259 LEVEL - TROL
FIG. 55 REMOTE RECEIVING INDICATOR
MULTI-TROL MOUNTED ON CONTROL VALVE
LIQUID LEVEL
SUPPLY
TYPE 2506 OR 2516 REMOTE RECEIVER CONTROLLER
TYPE 57T DIAPHRAGM MOTOR VALVE

FISHER®

Type 2516 Multi-Trol with Re-set

# *Dual Control* LEVEL-TROL

## VERSATILITY OF MOUNTING FOR EASY "ON THE SPOT" ADJUSTMENT

**This new Fisher Controller consists of a primary pilot (standard Fisher Series 2500 Level-Trol—used for indicating or controlling level) whose output is transmitted by pneumatic link to secondary pilot—the Multi-Trol.**

### MULTI-TROL FEATURES

**1—Available with reset (Type 2516) or without reset (Type 2506). (Reset may be added to units originally furnished without it.)**

**2—Proportional band adjustment is incorporated into the remote receiver controller with a range of 10% to 200%.**

**3—Level control point is adjustable manually in the case by level set adjustment. For remote set—provided with connection for remote air loading.**

**4—Pressure balanced type of relay provides intermittent bleed and gives accurate stable control.**

**5—Pilot may be changed from a direct acting to a reverse acting unit or vice versa, thru the use of switch plates.**

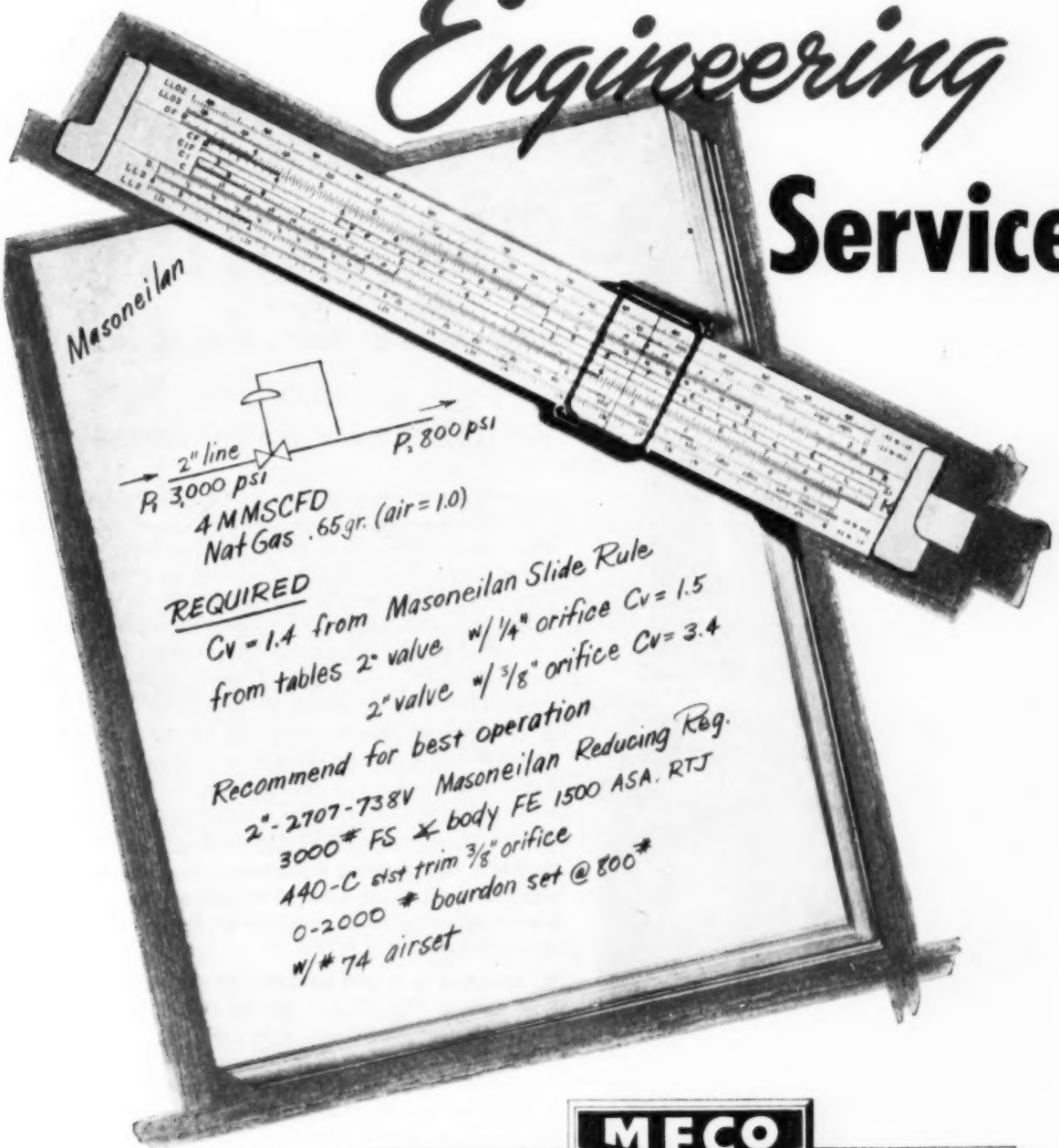
**6—Pilot may also be changed from proportional action to two position action or vice versa, by repositioning a switch plate.**

**Write for Bulletin F-2506**

**FISHER GOVERNOR COMPANY, Marshalltown, Iowa**

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

# Equipment with *Engineering* Service


Masoneilan
2" line
P, 3,000 psi
P, 800 psi
4 MMSCFD
Nat Gas .65 gr. (air = 1.0)
REQUIRED
Cv = 1.4 from Masoneilan Slide Rule
from tables 2" valve w/ 1/4" orifice Cv = 1.5
2" valve w/ 3/8" orifice Cv = 3.4
Recommend for best operation
2"-2707-738V Masoneilan Reducing Reg.
3000# FS ✕ body FE 1500 ASA. RTJ
440-C dist trim 3/8" orifice
0-2000 # bourdon set @ 800#
w/# 74 airset

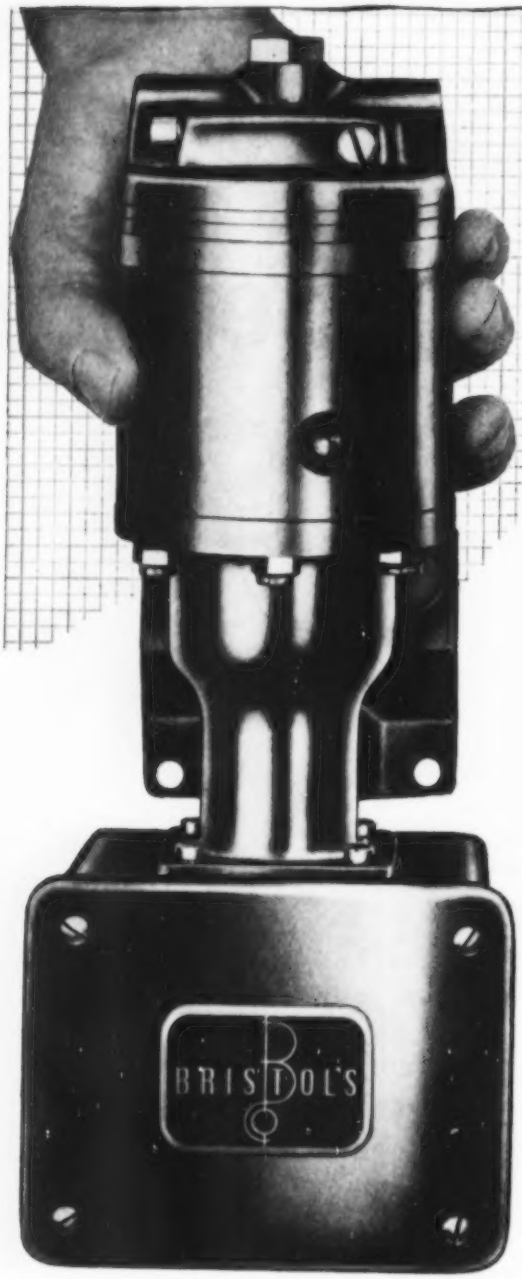
**MECO**

**MAINTENANCE** *Engineering* **CORPORATION**

P. O. BOX 2637

3711 CLINTON DRIVE
HOUSTON, TEXAS

WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL




# New Bristol Series 650
# PNEUMATIC TRANSMITTERS

*for use with*

**BRISTOL MINIATURE RECORDERS, INDICATORS, AND CONTROLLERS**

## . . . give you these new advantages

● **THEY USE BRISTOL WORLD-FAMOUS MEASURING ELEMENTS—the measuring elements with wide-angle travel for positive action.** These are the same standard Bristol measuring elements that are used in Bristol Recording and Controlling Instruments. They are the result of over 60 years of experience in instrument making and application in practically every industry. Bristol measuring elements are recognized the world over for their accuracy, simplicity, and reliability. There are no better measuring elements made than Bristol measuring elements.

● **TRANSMITTING UNITS PROVEN TO BE ABSOLUTELY RELIABLE AND TROUBLE-FREE. They are very sensitive** to extremely small changes in the measured quantity, as little as 0.03% of range, including reversal. Superior control results from the use of a booster valve with output capacity of 3.0 scfm

● **SIMPLE TRANSMITTING MECHANISM—frictionless operation**—only one pivot and no flexures—will operate in any position—is weatherproof and can be installed in any location, pipe-saddle or surface mounting.

● **AVAILABLE IN A WIDE SELECTION OF RANGES:** Pressure (0 to 5" water to 0-10,000 psi), vacuum (0 to 5" water to full vacuum), temperature (—100° F. to 1000° F.), liquid level (0 to 5" water and up), flow (mercury manometer, bell type, and Barton meter bodies), and differential pressure (0 to 2.0" water to 0-500" water). Suppressed ranges available. Over-range is standard, up to 500% for some ranges. Write for free bulletin No. A105. The Bristol Company, 111 Bristol Rd., Waterbury 20, Connecticut. 6.3.8.

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

# BRISTOL

*THE DEPENDABLE GUIDEPOST OF INDUSTRY*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

# What's going on here?

If you would tap one of these gentlemen on the shoulder and ask him to move aside a little to make room for you—you'd see one of the interesting exhibits prepared for the coming International Petroleum Exhibit.

Of course, there will be many such exhibits—and quite a few of them will be larger, have brighter lights or more machinery. But we think our exhibit will be of very direct interest and importance to every visiting oilman.

For the Ethyl display will demonstrate why the one thing you needn't worry about is your supply of "Ethyl" antiknock compound. Today "Ethyl" fluid is being manufactured in two entirely separate, integrated

(*Continued on next page*)

ETHYL
ETHYL CORPORATION

Printed in U.S.A.

## What's going on here?

(*Continued from preceding page*)

plants. One in Texas, the other in Louisiana. And there are also storage terminals in California and Delaware—so we can actually supply you from four locations.

We believe this ability to meet your needs from so many directions is one of the most important advantages enjoyed by Ethyl customers. In an emergency our four-point distribution setup could prove to be worth its weight in TEL. And—like Ethyl marketing services, research services and special programs in the farm, bus and truck, and aviation fields—it's all part of the "package" you get when you order antiknock fluid from Ethyl.

If you come to Tulsa to see the Exposition, we certainly hope you'll find time to drop in on us. Our exhibit is in the Kansas Building on the 21st Street side.

**ETHYL CORPORATION**
NEW YORK 17, NEW YORK

*Ethyl service is backed by 30 years of antiknock experience*

RESEARCH

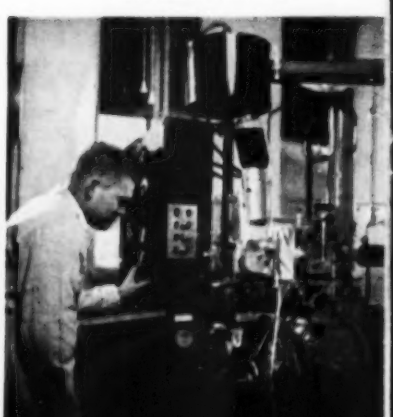
SALES HELPS

FARM SERVICE

ROAD TESTING

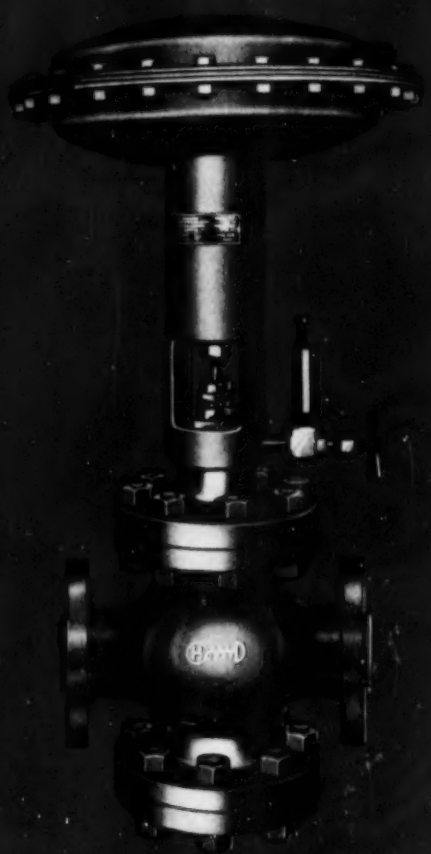
SAFETY SERVICE

GASOLINE TESTING



# Reduce Maintenance

ONLY
HAMMEL-DAHL
DECREASES
MAINTENANCE BILLS
with ALL these



## "ECONOMIZERS"

1. ALLSTEEL Superstructure.
2. Bolted packing box.
3. Forged fabricated bonnets and blind heads.
4. Through-bolted bonnets and blind heads.
5. Stainless steel spring stem.
6. Oilite Bearings, friction-free.
7. The "DAHL SEAL" — a frictionless Valve Stem Seal — of Teflon.
8. Metallic Bellows Seals of Stainless Steel, Monel, Nickel and Hastelloy.

Consult your nearest H-D Sales Engineer for Precision Control of Your Process

**HAMMEL-DAHL COMPANY**

175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.

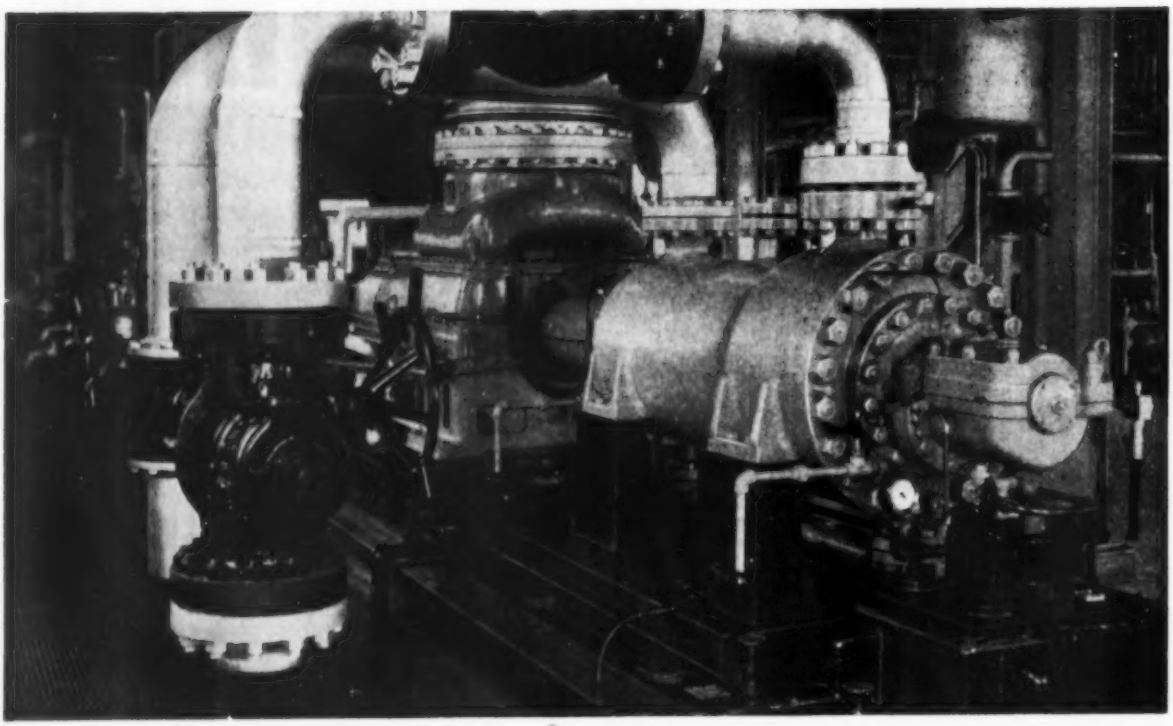
Albany Boston Buffalo Chicago Cincinnati Cleveland Denver Detroit Houston Kalamazoo
Kansas City Kingsport, Tenn. Los Angeles New Orleans New York Pittsburgh Salt Lake City
San Francisco Seattle Springfield, Mass. St. Louis Syracuse Toledo Tulsa Wilmington, Del.

MANUFACTURED AND DISTRIBUTED BY: *Canada* — The Guelph Engineering Co., Ltd., Guelph, Ontario
*England* — J. Blakeborough & Sons, Ltd., Brighouse, Yorks • *France* — Premafrance, Paris

## Ingersoll-Rand High-Pressure Pumps at the Katy Cycling Plant

# SET IMPRESSIVE RECORD

### of Maintenance-Free Operation



**years without opening!**

Two nine-stage CHT pumps were put into service at the Katy Cycling Plant in July 1943. These five-inch, double-case units, one of which is shown above, take lean oil at about 90°F. and 70 psi from the still after coolers and discharge it to the absorbers at 1850 psi. Throughout this entire nine year period, the pump casings have not been opened. The original bearing linings are still in service and the only maintenance required has been the renewal of inboard shaft sleeves and infrequent repacking. A third I-R pump of the same design, installed in 1944, has required no repairs to date.

This outstanding performance record is a typical example of the *extra dependability* that's built into every Ingersoll-Rand pump. Each unit is designed for real, long range economy that pays off in lower operating and maintenance costs year after year. If you have a pumping problem, your nearest I-R representative will be glad to help you.

**Ingersoll-Rand**

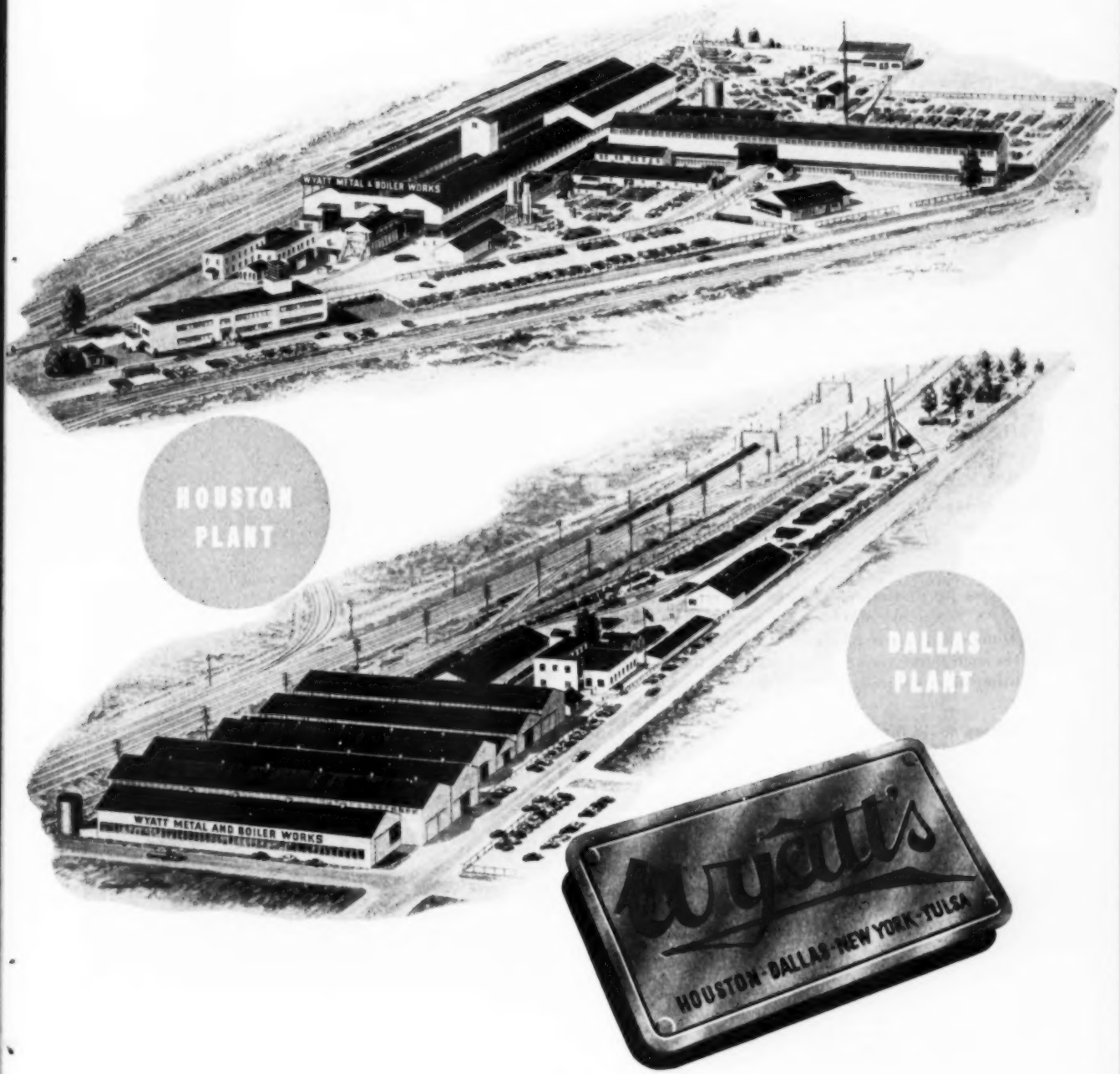
Cameron Pump Division
11 Broadway, New York 4, N. Y.

779-10

COMPRESSORS • DIESEL & GAS ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

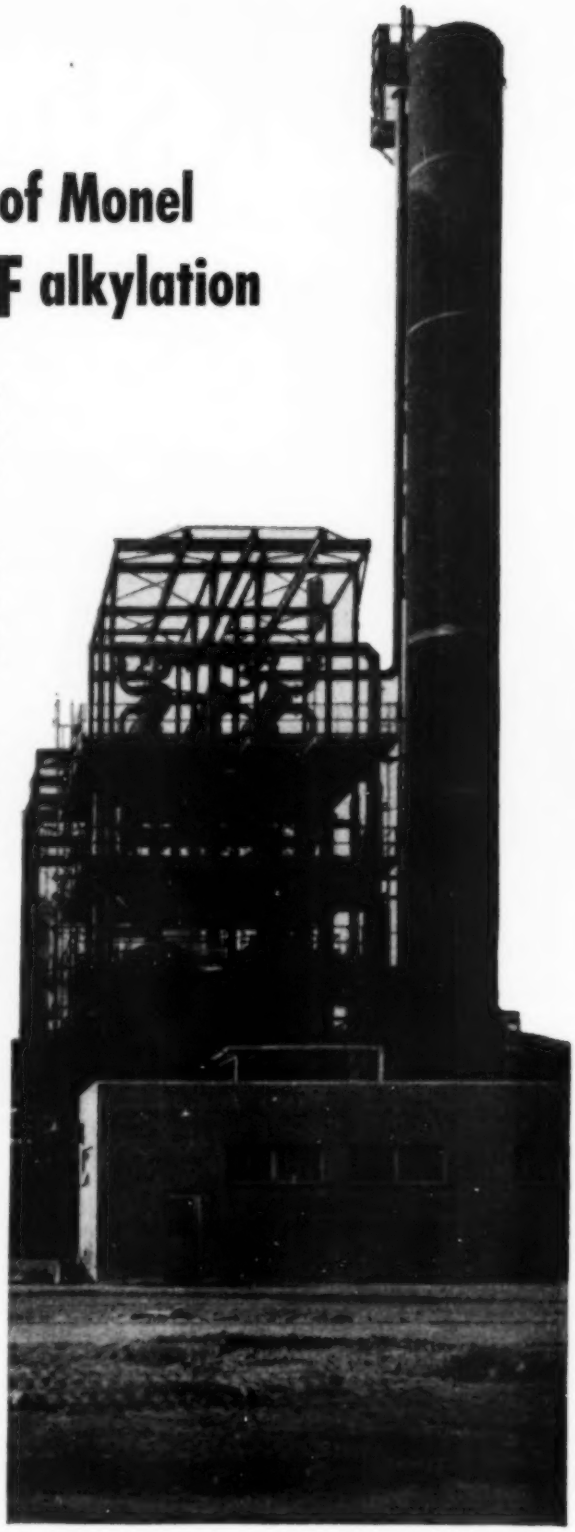
# Workshops...

## for the Petro-Chemical Industries




STEEL PLATE FABRICATORS AND ERECTORS SINCE 1913

# The "where" and "why" of Monel in HF alkylation



**Where there is a wide range of acid concentrations** ... Monel® is usefully resistant to *all* acid concentrations. That's most important, for example, in acid regeneration equipment where concentrations may vary from anhydrous to 38% solutions.

**Where there is a wide range of temperatures** ... Monel is resistant to corrosion in unaerated HF-water solutions, up to 250° F., a much higher temperature than various other metals can withstand. And with anhydrous acid, temperatures as high as 1100° F. can be used.

**Where velocity might cause excessive corrosion** ... Monel is relatively unaffected by velocities that increase the corrosion rates of other metals. For this reason, Monel is advantageously used in valves, pumps, pipe lines, and for bubble caps and linings in HF distillation columns.

**Where high strength is needed** ... "K"® Monel has all of the corrosion resistant advantages of Monel plus high strength. It is therefore most useful in parts such as pump shafts and valve stems.

**Where hardness and galling resistance are needed** ... "S"® Monel combines the corrosion-resistance of Monel with high hardness, and is especially suited for such parts as gate and plug valves, pump parts, and other parts where sticking or seizing must be avoided.

**Where could Monel be most useful to YOU?** Chances are Monel could be used at many points in your HF processing units to decrease corrosion and improve operations. Consult INCO'S Corrosion Engineering Section. They are always glad to help you.

Also, it is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

**Inco Nickel Alloys** INCO TRADE MARK **Monel**... *to muzzle HF*

# They Give...

## PERMANENT PIPE-LINE SECURITY

From *Master* Craftsmen come the world's finest *FITTINGS* . . . drop forged from solid billets of specially blended *STEELS*.

Your pipe connections can be harmonious and lasting . . . even endure beyond the normal life of the system . . . if proper consideration is given the compatibility of their meeting. Many millions of feet of pipe and tubing have been brought together by W-S Double-Diamond Forged Steel Fittings in lasting unions against time . . . heat . . . pressure . . . turbulence . . . corrosion . . . oxidation . . . vibration . . . reduction and shock.

Such fortunate meetings withstand the adverse conditions of *ANY* service environments because W-S FITTINGS are inherently superior to those made by methods other than PRECISION MACHINING from solid FORGED stock.

Whatever your pipe or tubing application, you can profit from the permanence of W-S Double-Diamond (Screw-End and Socket-Weld) Forged Steel Fittings.

**SOLD THROUGH LEADING DISTRIBUTORS**

SEE US IN THE
H. K. PORTER BUILDING

W
S

AT THE
TULSA OIL SHOW

## WATSON-STILLMAN FITTINGS DIVISION

## H. K. PORTER COMPANY, INC.

128 ALDENE RD., ROSELLE, NEW JERSEY

9-0-4

**Installing another Struthers Wells Mixing Vessel for processing HEAVY VISCOUS MATERIALS**

Struthers Wells **Double motion AGITATOR**

A — The double motion drivehead is an exclusive Struthers Wells design and is available in Horse Powers ranging from 2 to 150, and is furnished with proper sealing devices when it is used on pressure kettles.

B — Kettles can be open flat top as shown or equipped with a dished and flanged or similar closed top suitable for working pressures as high as 300 lbs.

C — Sweep and paddle arms are pitched to create a definite flow of material throughout kettle—preventing stratifying of mix. Scraper frame and paddle arms can be of welded design or bolted for easy removal through manway.

D — Scraper blades are of advanced hinged type design, which insures positive scraping action on 98% of inside surface of mixer—without necessity of boring shell or bottom head.

E — Constructed of any standard steel or special alloy to meet most exacting specifications.

F — Kettles are furnished with jacket or unjacketed for direct fire applications.

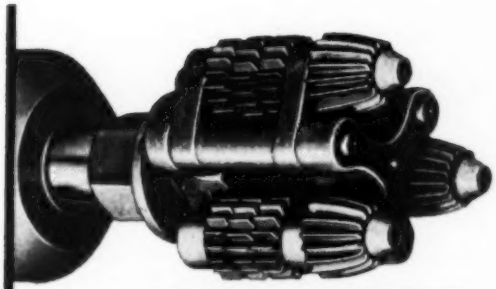
For speed, economy and dependability—specify the Struthers Wells Double Motion Mixing Vessels—for processing greases and other heavy viscous materials. Our extensive machine shops and fabricating facilities—combined with years of engineering experience in designing all types of agitating vessels, enable us to furnish mixing equipment for any material, to your most rigid specifications.

For intricately designed or standard mixing equipment—*think first of Struthers Wells.*

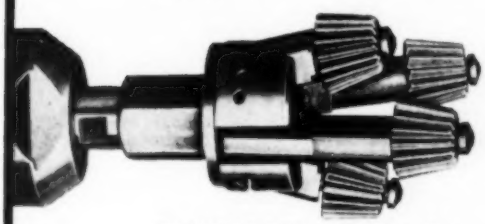
**Struthers Wells CORPORATION**

PROCESSING DIVISION • WARREN, PA.
PLANTS AT WARREN AND TITUSVILLE, PA.

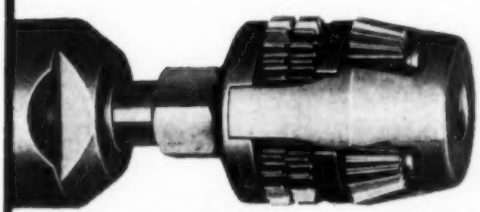
# What kind of coke do you have?



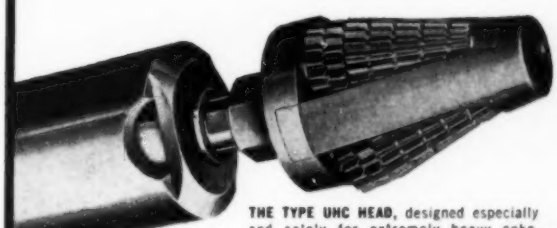
**THE LONG-SURFACE SWING-FRAME HEAD** with plenty of expansion for tubes of wide tolerance.



**THE TYPE H-2 HEAD,** particularly good on uneven coke deposits.



**THE TYPE U0 HEAD,** most widely used for its adaptability to average coke conditions.



**THE TYPE UHC HEAD,** designed especially and solely for extremely heavy coke.

Whatever kind you have, some one of these cutter heads is sure death to it, designed for that particular coke and with a long record of success in its specific field.

Every one of these heads has proved itself thousands of times to have the toughness needed at the business end of the famous 1100 Series Lagonda motor, which in its superspeed and power can wreck any head not built for extra tough duty. It's a combination that clicks—Lagonda head and Lagonda motor. Try it out when the going is slow and breakages hold up the job. Your local Elliott-Lagonda representative will cooperate, or write direct to Elliott Company, Springfield, Ohio.

**LAGONDA**
*—the oldest name in tube cleaning*

**THE FAMOUS 1100 SERIES MOTOR,** whose exceptional power requires the especially enduring design and construction common to all the heads here illustrated.

**THE 3600 SERIES DUPLEX CUTTER HEAD,** a double or wide expansion type.

**ELLIOTT Company**
**LAGONDA DIVISION**

Y3-5

# Licked before they start!

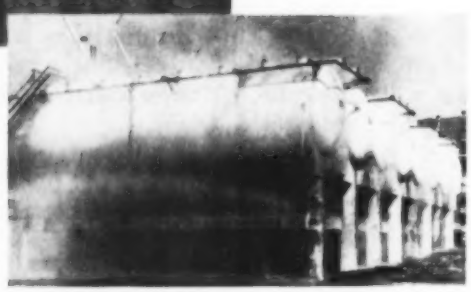
## BLAW-KNOX FOG SYSTEMS DON'T GIVE FIRES A CHANCE TO GROW UP

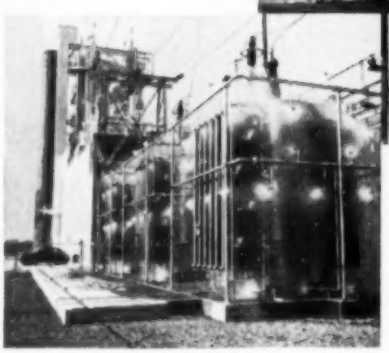
Chemical and petroleum fires strike fast with little or no warning. But not so fast that a Blaw-Knox Fog System actuated by rate-of-rise thermostats can't knock 'em out with a smothering blanket of fog *before* they really get started.

A Blaw-Knox System engineered for the fire hazards existing in or around your plant is a most effective weapon against fire's toll. On the job 24 hours a day, it protects your property as well as products essential to our national economy.

Glad to consult with you and submit an estimate without obligation.

**BLAW-KNOX COMPANY**
**SPRINKLER DIVISION**
**Pittsburgh 33, Pa.**





*Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems, and Foam and Carbon Dioxide Extinguisher Systems.*

**"LITTLE JOEY SPRINKLER"**
**Always on the Job**

# BLAW-KNOX AUTOMATIC FIRE PROTECTION SYSTEMS

*Reprinted from* ***THE OIL DAILY****, February 18, 1953.*

## Keith Fanshier

# FROM NOW ON

TIME WAS in the petroleum industry when volume was the controlling factor in net profit. A volume increase would cure almost anything.

The industry was expanding rapidly. Costs were moderate. By a little ingenuity here and there cost increases could be offset. There was breathing-space.

Times have changed. Costs everywhere have soared, alarmingly. Prices of what the industry has to sell have been held down since wartime by government controls and by probably the most severe competition existing in any industry.

That easy breathing-space no longer is there. Things are tight, all along the line.

• • •

In these circumstances, volume alone is no longer the answer. No more can inherently unsound operations be cured or glossed over by an increase in volume. Larger volume in an unsound situation now will only complicate conditions.

Now even more than ever, for instance, will price wars accomplish nothing—nothing but waste, loss, worry and misery for participants, a reproach upon the industry, and a lower standard of service to public and nation. Also a lower "standard of living" for the oil industry.

The members of this oil industry are in a battle of survival with their costs. A pity of it is that some seem not to recognize the fact, or perhaps even don't know the true meaning of the term: costs.

One thing is sure: cost-consciousness will pay off in this year 1953. That's true of every single operation from the gleam in the eye of a geologist on a mountainside to the cut-off of the hose nozzle in the motorist's tank.

• • •

That should make possible a fair, compensating price structure. That will give this industry a reasonable profit, the public dependable service, the nation a fine contribution to security.

Who says costs are not important? They are this important. Their recognition and recovery is just about the most urgent problem this industry faces this year, and for a long future, if it wants to continue being an industry.

From now on it will take more than volume.


**One of the most dramatic sources of economy in modern processing practice is the Ljungstrom Air Preheater. For details, consult The Air Preheater Corporation.**

***THE AIR PREHEATER CORPORATION***

**60 East 42nd Street**

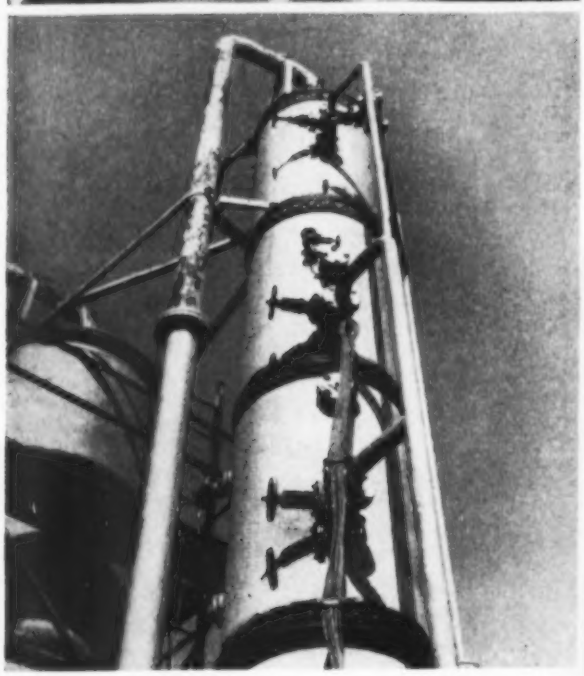
**New York 17, N. Y.**

***Wherever you burn fuel, you need Ljungstrom***

**THESE TEN-YEAR-OLD PUMPS** for circulating organic acids are built entirely of Stainless Steel. In spite of their long service, they are still in very good condition.

**STAINLESS STEEL** also resists corrosion in the column and kettle of this batch still kettle for distillation of esters. The equipment, still in good condition, has been in use three years.

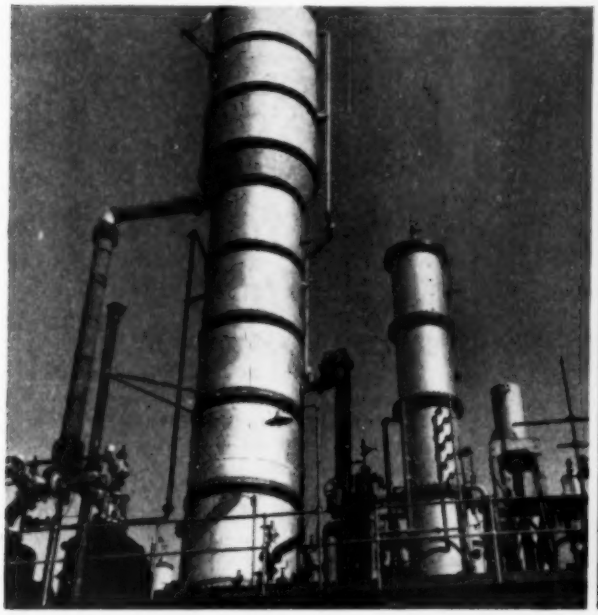
# For corrosion resistance



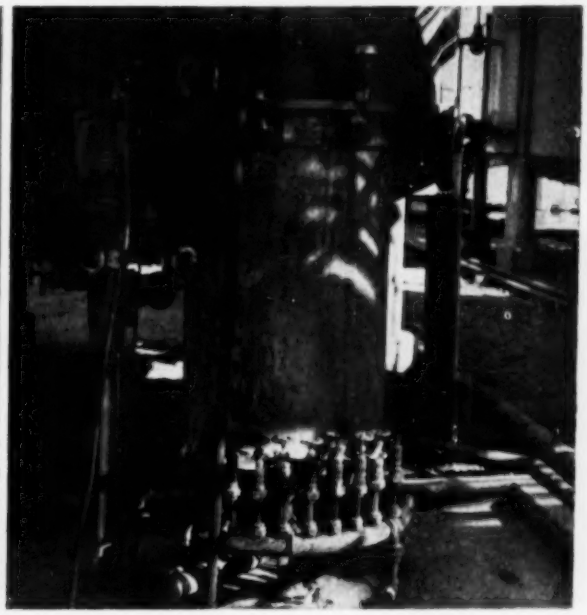
**STAINLESS STEEL STRIPPING MILL** is used for removing water from organic liquids. It is four years old and still ready for more service.

**ALL PARTS** of this automatic bagging machine in contact with hot resin are Stainless Steel. Stainless is used to prevent contamination of vinyl resin.

**VESSEL AND ALL INTERNALS** of this still for distillation of acetic acid are Stainless Steel for resistance to corrosion. The Stainless is in good condition after three to four years' service.



**OLIVER LEAF FILTER,** used to remove salt from an organic base, has shell, leaves and valves of Stainless Steel. In service between four and five years, it is in excellent condition.



# in petro-chemical operations

## THIS MAJOR TEXAS PRODUCER SELECTS

# STAINLESS STEEL

● At its big Gulf Coast operation, this producer of petro-chemicals makes extensive use of Stainless Steel in many types of processing equipment.

In some of these applications, Stainless Steel's resistance to corrosion led to its selection. In others, the absence of product contamination that Stainless assures was the determining factor.

These are only two of the important benefits of Stainless Steel in chemical processing equipment. Others include ease of cleaning, elimination of downtime for replacement, excellent performance in certain high temperature operations or when high pressures are involved.

It will pay you to investigate the use of Stainless Steel in your plant wherever you need these benefits. And if you want the finest performance, be sure you use perfected, service-tested U·S·S Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

**U·S·S STAINLESS STEEL**

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

3-1087

**UNITED STATES STEEL**

**SMOKE BLOWN THROUGH** a Norton ALUNDUM* *seamless* tube escapes throughout the tube's entire area. Such a tube gives most efficient filtration and ease of cleaning by back washing. When selecting tubes for your specific application be sure they embody this important feature.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

# *Why Norton seamless tubes give you better filtration*

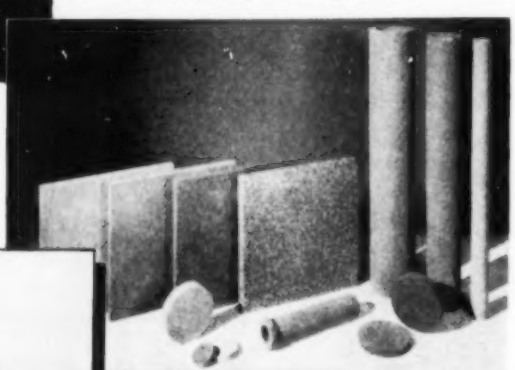
Only Norton ALUNDUM tubes have the seamless construction that means more uniform filtration and enables faster, more thorough cleaning. And like all Norton porous mediums they're made with the patented *controlled structure* process that assures even distribution of pores — in the size and open-pore ratio that best meets your needs.

### *Cost-cutters over a wide job range*

In any form, Norton porous mediums have exceptional resistance to breakage, chipping and acid and alkaline conditions. They're designed to perform better, last longer and cut your operating costs in a wide variety of chemical field applications. For example: filtering water or solvents . . . cutting oils, wine and other liquids . . . reclaiming cleaning fluids and industrial waste . . . in boiler feed water treatment.

### *Get the whole story*

See your Norton Representative for complete facts on how you can get more savings and satisfaction with Norton porous mediums. Or write describing your requirements, to NORTON COMPANY, 464 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.



**NORTON ALUNDUM POROUS MEDIUMS** are available as tubes, plates and discs in a wide range of sizes.

NORTON

## *POROUS MEDIUMS*

*Making better products to make other products better*

**NORTON COMPANY, WORCESTER 6, MASSACHUSETTS**

# PEERLESS BUILDS *Dependable* PUMPS

PEERLESS PUMPS

VERTICAL

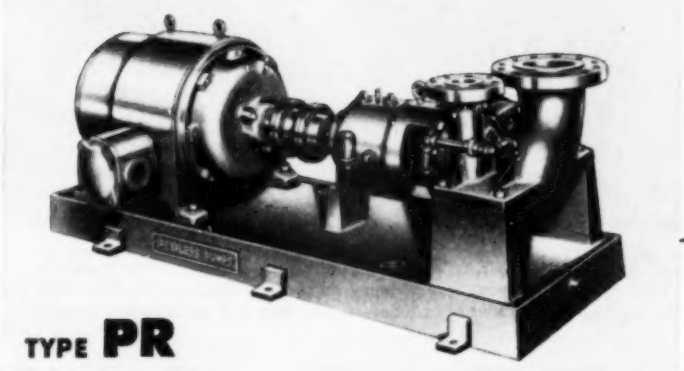
HORIZONTAL

## USE THE VERTICAL HYDRO-LINE PUMP WHERE YOUR APPLICATION REQUIREMENTS ARE:

Low System NPSH; Moderate Capacities; High Pressures; High Temperatures; Extreme Installation Flexibility; Optional Mechanical Shaft Seal or Packing Gland Construction; Economical Service and Maintenance; Operational Dependability; Wide Range of Liquid Pumping Services, such as Condensate, Hydrocarbons, Hot or Cold Water, Mild Salt Solutions. For descriptive Bulletin No. B-592, check and mail coupon.

## USE THE HORIZONTAL TYPE PR PUMP WHERE YOUR APPLICATION REQUIREMENTS ARE:

Rugged Center-Line-Mount Construction; High Temperatures; High Pressures; High Capacity; Extra Low NPSH Requirements; Optional Use of Mechanical Shaft Seal or Packing Gland Construction; End or Top Suction Design; Dependable Performance with Minimum Maintenance; Availability in Various Alloys; A Complete Range of Sizes; Maximum Parts Interchangeability; Wide Range of Liquid Pumping Services, such as Hot Oil, Butane, Propane, Hydrocarbons, Hard-to-Handle Chemicals and Water. For descriptive Bulletin No. B-1605, check and mail coupon.



TYPE **PR**

*See Our Exhibit*
**OIL SHOW**
**TULSA** MAY 14-23

**MAIL COUPON TODAY**

PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26
Los Angeles 31, California

Please send us a copy of the following bulletins:

☐ VERTICAL HYDRO-LINE PUMP ☐ HORIZONTAL TYPE PR PUMP

NAME _____

COMPANY _____

STREET _____

CITY _____ STATE _____

PR

**PEERLESS PUMP DIVISION**
*Food Machinery and Chemical Corporation*
Address inquiries to Factories at:
Los Angeles 31, California and Indianapolis 8, Indiana
OFFICES: New York; Chicago; St. Louis; Atlanta; Tulsa; Dallas, Plainview and Lubbock, Texas; Fresno, Los Angeles, Calif.; Phoenix; Albuquerque, New Mexico

PEERLESS PUMPS

fmc

# puts the HEAT on heat exchangers

By changing to Yarway Impulse Steam Traps, an oil refinery reports much hotter steam in their heat exchangers **—plus two other important extras:**

(1) They were able to operate the plant with 6 boilers instead of the 8 formerly required.

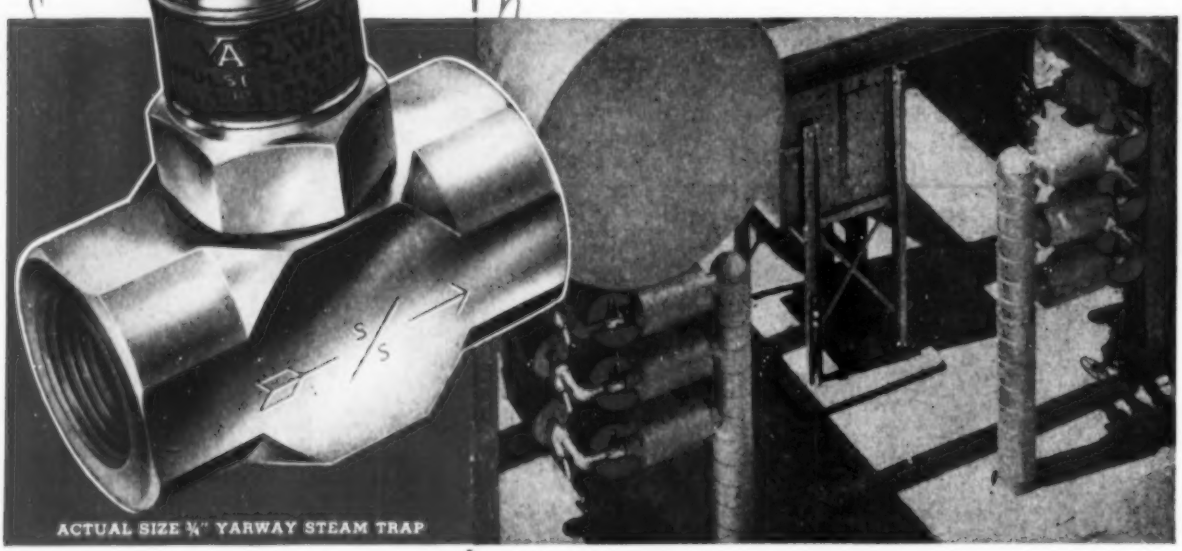
(2) Three men formerly required to service old-type traps can now be used for productive work.

Significant sidelight—these Yarway traps are operating under severe conditions, many outdoors with temperatures often below zero.

Plant after plant is standardizing on Yarway Impulse Steam Traps because Yarways are designed to deliver the most premium B.T.U.'s at top temperatures into your process or product. **They get equipment hotter, sooner ... and keep it hot.**

Other reasons—small size, easy installation, good for all pressures, only one moving part, low maintenance, low price.

Buy your Yarway Impulse Steam Traps from the nearest of 216 distributors. For name, write us.



ACTUAL SIZE ¾" YARWAY STEAM TRAP

**YARNALL-WARING COMPANY**
128 Mermaid Ave., Philadelphia 18, Pa.

**FREE OFFER.** Don't take our word for it. Test Yarway's advantages in your own plant, without cost or obligation. Drop us a card or letter—a trial trap will be delivered promptly.

**YARWAY** the steam trap
**designed with more production in mind**

## . . . another place where REPUBLIC

# ELECTRUNITE PRESSURE TUBES

## DO THE JOB BEST . . .

When you take heat exchangers off-stream for retubing, make sure you increase the time between retubings . . . install Republic ELECTRUNITE Pressure Tubes.

You have your choice of carbon steel tubes and several analyses of ENDURO Stainless Steel tubes . . . all made by the ELECTRUNITE process which assures uniformly round tubes inside and out, uniform wall thicknesses and uniform bending and expanding characteristics.

And you needn't wait until retubing to get the long-lasting benefits of Republic ELECTRUNITE Tubes . . . leading manufacturers of heat exchanger equipment know and use these time-proven tubes for many *new* condensers and heat exchangers.

*Write for Booklet giving specifications and design data on Republic ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubes.*

**STEEL AND TUBES DIVISION**
**REPUBLIC STEEL CORPORATION**
**220 EAST 131st STREET • CLEVELAND 8, OHIO**

***ELECTRUNITE—The Original Electric Welded Boiler Tube***

*Republic*
**ELECTRUNITE**
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

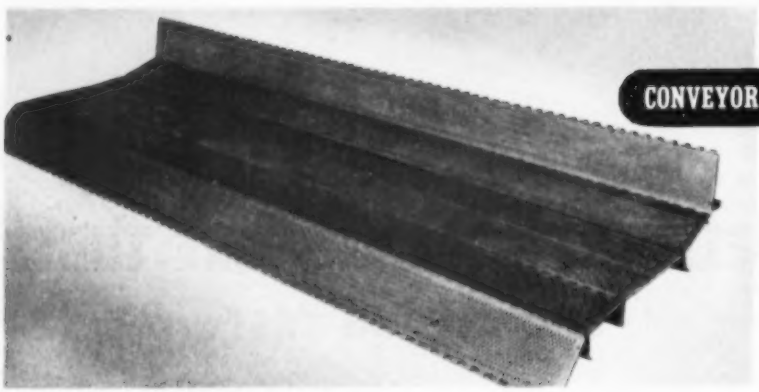
REPUBLIC STEEL

# *We invite you to* INQUIRE OF·· The PRESSED STEEL CO. PSC ····

when you want data from
**SPECIALISTS IN**

## ALLOY BUBBLE CAPS FOR OIL REFINING

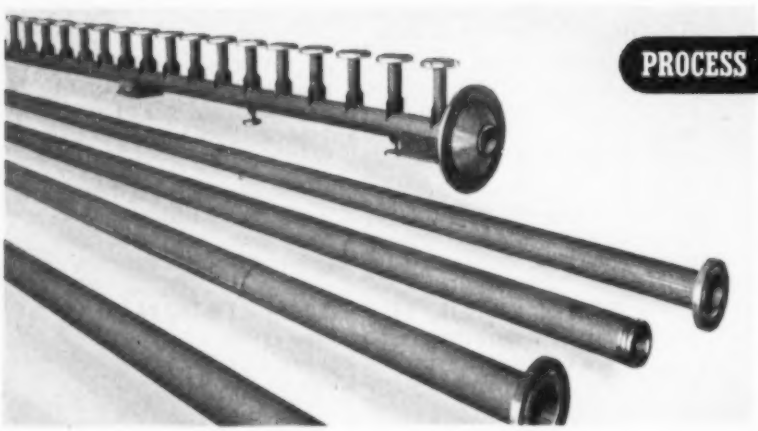
You will find, we believe, the largest compilation of engineering data on bubble caps and risers in PSC Catalog 52. All standard styles; furnished without die cost and in any alloy. Special caps to your order.



## CONVEYOR FLIGHTS FOR SYNTHETIC RUBBER

Used on dryer conveyors in most plants. In any alloy, and specifications as to size and perforations. A typical example of PSC's precision sheet alloy fabrication for the process industries.

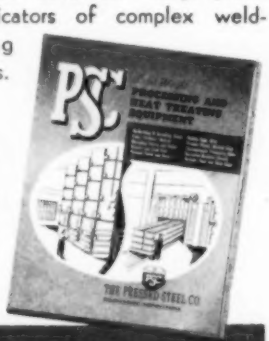
Piping in any diameter up to 60″; any section to ⅜″; of any alloy, permitting use of the particular metal best suited to a specific heat (to 2200°F)



## PROCESS PIPING FOR PETRO-CHEMICALS

or corrosion condition. Large precision fabricators of complex welded tubing assemblies.

*Send for*
**Process Equipm't CATAL'G 52**




**THE PRESSED STEEL COMPANY**
of WILKES-BARRE, PENNSYLVANIA

*Industrial Equipment of Heat and Corrosion Resistant* WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

# REFINERY PROCESS NEWS

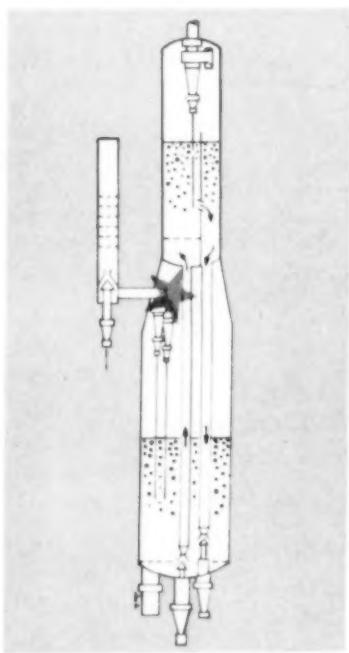
PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY — MAY 1953

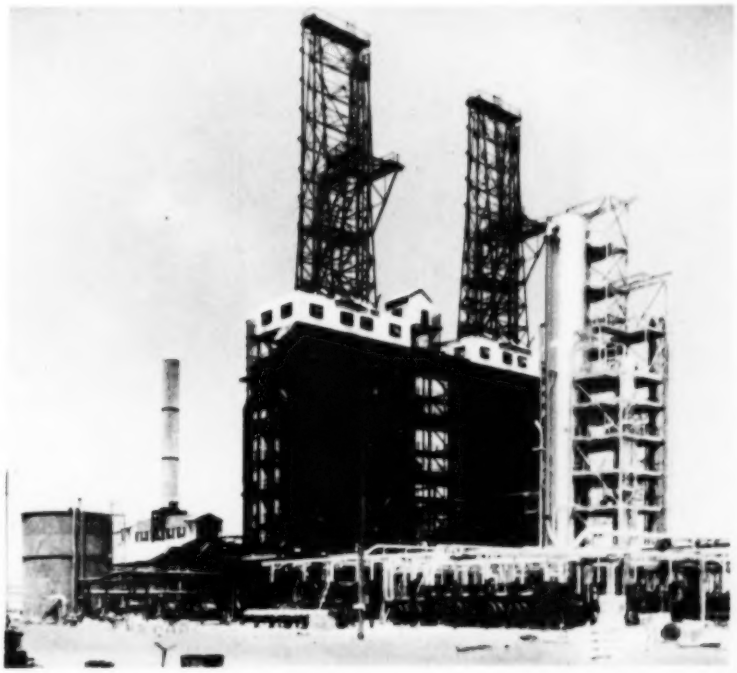

## Simple Change in Orthoflow Unit Radically Reduces Catalyst Loss!

A comparatively simple modification in the regenerator of the first domestic Orthoflow unit has radically reduced amount of catalyst lost with stack gases. Tests over a period of better than two months prove that the catalyst loss factor of the Orthoflow is now as low as that of the best side-by-side Fluid units. Gasoline yields from this unit also continue to match the best yield records of the conventional crackers.

While designed for an 8300 BPD throughput, this first unit has been operating on synthetic MS catalyst at 9300 BPD — with conversion maintained at 67% because of the weak fuel oil market. In operation, the debutanized gasoline averages 93 octane clear, despite the fact that a certain percentage of naphtha is present in the feed.

The modification made in equipment to effect the catalyst saving does not alter the basic design of Orthoflow units nor affect their low investment advantages. Currently nine other Orthoflows are either operating, under construction or being engineered.





## Changing Product Economics Increases Interest in Delayed Coking Process

In view of the deteriorating market for residual fuel oil in certain areas and no indications that it will greatly improve in the future, refiners in many parts of the country are reaching the decision that a coking step is the most logical solution to this economic problem.

Not only has the moderate winter piled up supplies of residuals in several sections of the country but basic industry uses have continued to slack off. Exports are down and no one can reliably predict that import restrictions will not be lifted.

While this situation does not obviate the use of other feed preparation steps (for example, Kellogg was named just recently to design and erect a 55,000-BPD vacuum flasher on the West Coast and is currently building a 28,000 BPD solvent deasphalter on the Gulf Coast) it does place Delayed Coking in a key position.

Petroleum coke is marketable today in virtually every part of the country — in contrast with the situation a few years ago when it had value only as refinery fuel in a number of locations. Further its price ranges as high as $10 a ton or more, depending on quality. In addition to customary uses, there is an increasing demand for petroleum coke in the manufacture of the carbon electrodes used in aluminum production. Roughly seven-tenths of a pound of petroleum coke is required to produce one pound of primary aluminum.

All-in-all, it appears that the U. S. and Canada will consume well over a million tons of petroleum coke this year. By 1955, this same potential market may rise by nearly 50%.

The following brief economic evaluation of two major feed prep steps highlights their economic relationship under current market conditions. The study is based on

(continued on following page)

CONTINUED FROM PRECEDING PAGE

## Delayed Coking . . . cont.

a typical refining sequence including recycle Fluid cracking, thermal reforming of naphtha, cat poly and alkylation. Feed was established as 40,000 BPD of 38.6° API paraffinic crude, topped to 32.5% bottoms, plus 4000 BPD of 26 lb. casinghead.

### YIELDS, VOLUME % ON CRUDE

| | Vacuum Dist. | Delayed Coking |
|---|---|---|
| Premium Gasoline–93 CFR-R | 13.2 | 14.0 |
| Regular Gasoline–86 CFR-R | 54.1 | 56.1 |
| Total Gasoline | 67.3 | 70.1 |
| Kerosene | 12.0 | 12.0 |
| Furnace Oil | 11.4 | 10.7 |
| Fuel Oil | 10.1 | 3.0 |
| Gas (fuel oil equivalent) | 8.3 | 11.0 |
| Coke (recoverable) | — | 5.4 |

### ASSUMED PRICE STRUCTURE

| | Gulf Coast Unit Price | East Coast Unit Price |
|---|---|---|
| Premium Gasoline–93 CFR-R, per Gal. | $0.1225 | $0.1385 |
| Regular Gasoline–86 CFR-R, per Gal. | 0.1125 | 0.1285 |
| Kerosene, per Gal. | 0.0925 | 0.1075 |
| Furnace Oil, per Gal. | 0.08625 | 0.0975 |
| Fuel Oil, per Bbl. | 1.63 | 2.10 |
| Gas (fuel oil equivalent), per Bbl. | 0.66 | 2.10 |
| Coke (recoverable), per Ton | 10.00 | 10.00 |

### ECONOMIC COMPARISONS

| | Delayed Coking |
|---|---|
| *Incremental Credits over Vacuum Distillation, per year* | |
| East Coast | $1,207,000 |
| Gulf Coast | 1,153,000 |
| *Incremental Investments in Processing Equipment* | |
| East or Gulf Coast | 1,400,000 |

## New Low Cost Desulfurization Demonstrated

Recently completed at Llandarcy by Anglo-Iranian Oil Company, Ltd. this 3,500 BPD Autofining unit is typical of a type of plant now being licensed on a worldwide basis by Kellogg. In view of the increasing quantities of sour crudes being used by domestic refiners, a desulfurization process like this one could be of great importance to processors who are having difficulty meeting sulfur specs for diesel and heating oils.

Autofining is fixed-bed catalytic desulfurization designed to treat all types of distillate stocks except those which include a high percentage of unsaturates. It is a low temperature, moderate pressure, high space-velocity process which provides an excellent low cost means of producing sweet distillates from sour crudes with extremely low liquid volume losses and with high sulfur reduction.

For a unit of 3,500 BPD capacity, the direct operating cost per barrel of feed ranges from about 11 cents for gas oil to 10 cents for kerosene. This can be compared with conventional sulfuric acid treating costs of 48 and 16 cents respectively. Investment cost for an Autofining unit is somewhat greater than that for acid treating. Nevertheless, incremental payout time for the new process over acid treating is approximately one year for gas oil operation and slightly longer for kerosene operation, depending on sulfur reduction.

***For further information, technical data, etc., on any refining process, write***

## ARGENTINIAN REFINERY . . . 75% COMPLETE

Work has reached the 75-per-cent-completion stage on a 28,300-BPD catalytic refinery in the Argentine. The new plant is being erected by Yaciementos Petroliferos Fiscales at Eva Peron (formerly La Plata) and will be called the Presidente Peron Refinery.

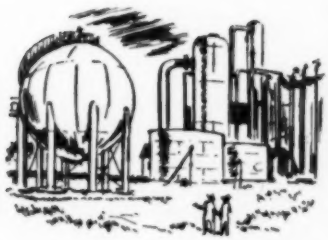
Shown are two of the major units, vacuum distillation to the left, and straight-run gasoline fractionation to the right. Other units, being constructed by YPF under the supervision of Kellogg Pan American Corporation, include a Fluid catalytic cracker, an alkylation unit and one of the world's largest Delayed Cokers. In addition, there will be two crude units, one of 21,000 BPD capacity and the other charging 7300 PBD. Thermal cracking and catalytic polymerization are also part of the sequence.

REFINERY PROCESS DIVISION
THE M. W. KELLOGG COMPANY
225 Broadway, New York 7, N. Y.
Also Jersey City, Los Angeles, Tulsa, Houston, Toronto, London and Paris
KELLOGG PULLMAN

KELLOGG
FLUID CATALYTIC CRACKING
KELLOGG
FLUID HYDROFORMING
KELLOGG
LUBE PROCESSING
KELLOGG
PETRO CHEMICAL PROCESSING
KELLOGG
CAT POLY ALKYLATION
KELLOGG
DISTILLATION
KELLOGG
VACUUM DISTILLATION
KELLOGG
DECARBONIZING DESULFURIZATION

*New Powerful Weed Killer Cuts Fire Hazards*

*for* **OIL INDUSTRY**



# Du Pont CMU

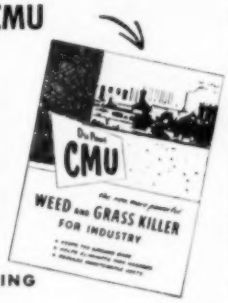
## KILLS WEEDS AND GRASS AND PREVENTS REGROWTH

Small quantities of Du Pont CMU kill weeds and prevent regrowth. CMU controls most species that are a fire hazard around tank farms, oil and gas wells, refineries, pumping stations, above-ground pipelines and barrel yards.

- Economical, low application rates usually keep ground clear through an entire growing season or longer. As little as 40 to 60 lbs. per acre or 1 to 1½ lbs. per 1,000 square feet often does the job.
- Kills most kinds of weeds and grass and prevents regrowth. It works through the roots . . . just spray it on the ground.
- Eliminates fire hazards caused by unwanted vegetation.
- Saves work, cuts maintenance. One spray with CMU takes the place of repeated hand cutting, mowing, or other less effective means.
- Non-flammable, non-volatile, non-corrosive. Comes as a wettable powder to mix with water.

**Get This Full-Color, Illustrated Booklet Showing Results With CMU**

*Also tells how to use it. For your copy, use the coupon.*




DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

A-5

E. I. du Pont de Nemours & Co. (Inc.)
Grasselli Chemicals Dept., Wilmington, Del.

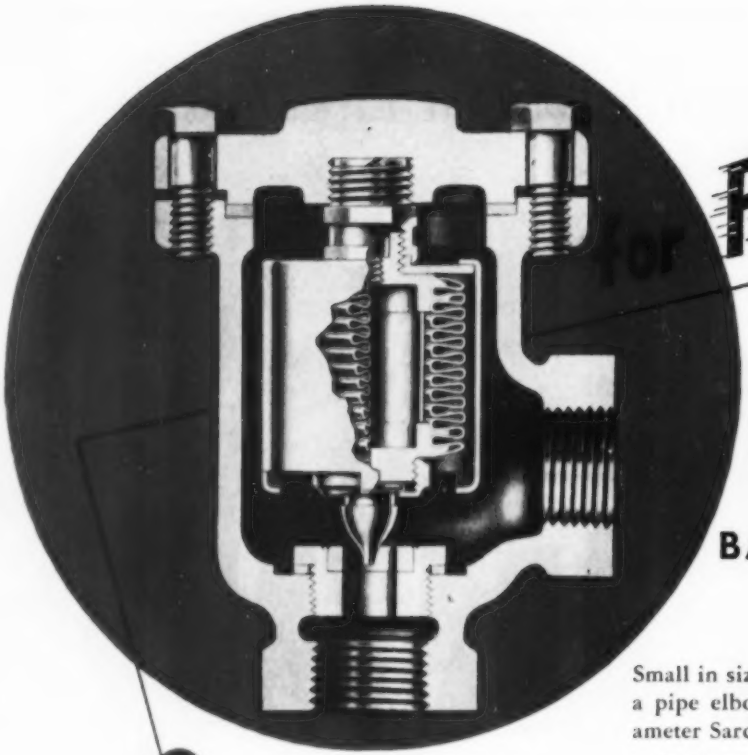
Please send me illustrated booklet and other information about CMU.

Name_____

Firm_____

Street_____

City_____ State_____



Sarco Thermostatic Steam Trap No. 9, available in sizes ½" to 2" for pressures to 300 psi. Bellows are phosphor bronze, monel or stainless steel as required, shielded from abrasion. Renewable valve heads and seats are of stainless steel.

for **FAST ACTION**

use

# SARCO

## BALANCED PRESSURE THERMOSTATIC STEAM TRAPS

Small in size; light in weight, as easy to install as a pipe elbow, these new traps employ large diameter Sarco bellows proportioned to trap size.

Condensate only a few degrees below steam temperature snaps the large valve wide open. That means rapid and complete venting of air and non-condensables.

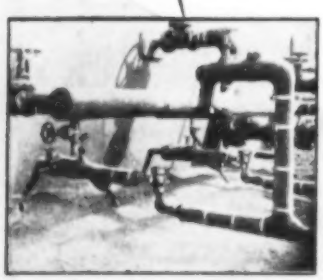
It means also exceptionally large condensate capacities.

Actually the balanced pressure type thermostatic trap has the highest discharge capacity per dollar cost.

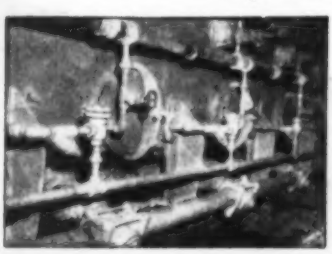
Other advantages: no seats to change when pressures change (fewer spares to carry); requires no protection against freezing.

***WRITE for free copy of new catalog 256***

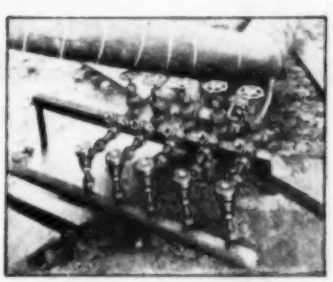
355



Sarco No. 9-225 traps and strainers draining steam heating coils in crude oil storage tanks.



Sarco No. 9-125 traps and strainers on bottle washer in brewery.



Sarco No. 9-300 traps and strainers removing air and condensate from steam tracer lines maintaining asphalt to storage tanks at pumping temperature.

**SARCO COMPANY, INC.**

EMPIRE STATE BUILDING, NEW YORK 1, N. Y.

SARCO CANADA LTD., TORONTO 5, ONTARIO

REPRESENTED IN PRINCIPAL CITIES

# STOPS CORROSION

**It's worth checking into** — one of the many Tygon Plastic formulations may be the answer to your tough corrosion problems.

**LIQUID TYGON**
quickly applied coating, as protection against corrosive fumes.

**EXTRUDED TYGON**
Tubing, channel, special shapes, solid cord.

**MOLDED TYGON**
Gaskets, grommets, diaphragms, molded mechanical items.

This dense, impermeable, 3/32" thick press-polished ***Tygon*** Sheet plastic shrugs off corrosives that quickly destroy rubber and other lining materials.

***Tygon***-lined equipment will handle safely all reducing acids as well as such highly oxidizing acids as chromic, hydrofluoric, nitric and sulphuric. ***Tygon*** is completely unaffected by oxidation.

***Tygon*** sheet plastic wears well. Its tough sturdiness resists abrasion; it is easily repaired if accidentally gouged or damaged; its mirror-smooth surface stays clean longer.

The next time you're faced with one of those "tough" lining jobs, talk to our engineers about ***Tygon.***

**U. S. STONEWARE**
*Akron 9, Ohio*

MANUFACTURERS AND FABRICATORS OF CORROSION RESISTANT MATERIALS AND EQUIPMENT SINCE 1865

# Graphic Instrumentation . . . *from idea to installation*

SIMPLER supervision, greater operating efficiency . . . improved coordination . . . these are some of the contributions that graphic instrumentation is making in the process industries. Recognizing the ever increasing importance of graphic techniques, Honeywell offers complete engineering service . . . covering instrumentation, panel design, and construction.

### Instruments

*Tel-O-Set* miniature indicators and recorders are supplied for temperature, pressure, flow and liquid level. They take a front-of-panel space only 5 inches square . . . fit readily into process diagrams. They meet the most critical demands for accuracy, simplicity, and utility.

Behind the panel are compact *Tel-O-Set* Controllers. They provide a choice of control actions.

Console desks, with integrally-mounted *ElectroniK* Precision Indicators, give operators a convenient means of monitoring a large number of critical temperatures.

For remote transmission, Honeywell has a full line of temperature, pressure, flow and level transmitters and receivers of both pneumatic and electric types . . . working with a broad selection of sensing elements.

### Panel Design

Every panel is custom-designed for its intended job by Honeywell's staff of panel engineers. After initial consultations, they develop a layout that fits all instruments, signals, remote control stations and other equipment in a coordinated design. All elements are located for greatest convenience and ease of manipulation. The overall appearance is made attractive and simple to follow, to aid in reducing operator fatigue. Final working drawings are prepared following consultation with the customer . . . then actual fabrication begins.

### Panel Construction

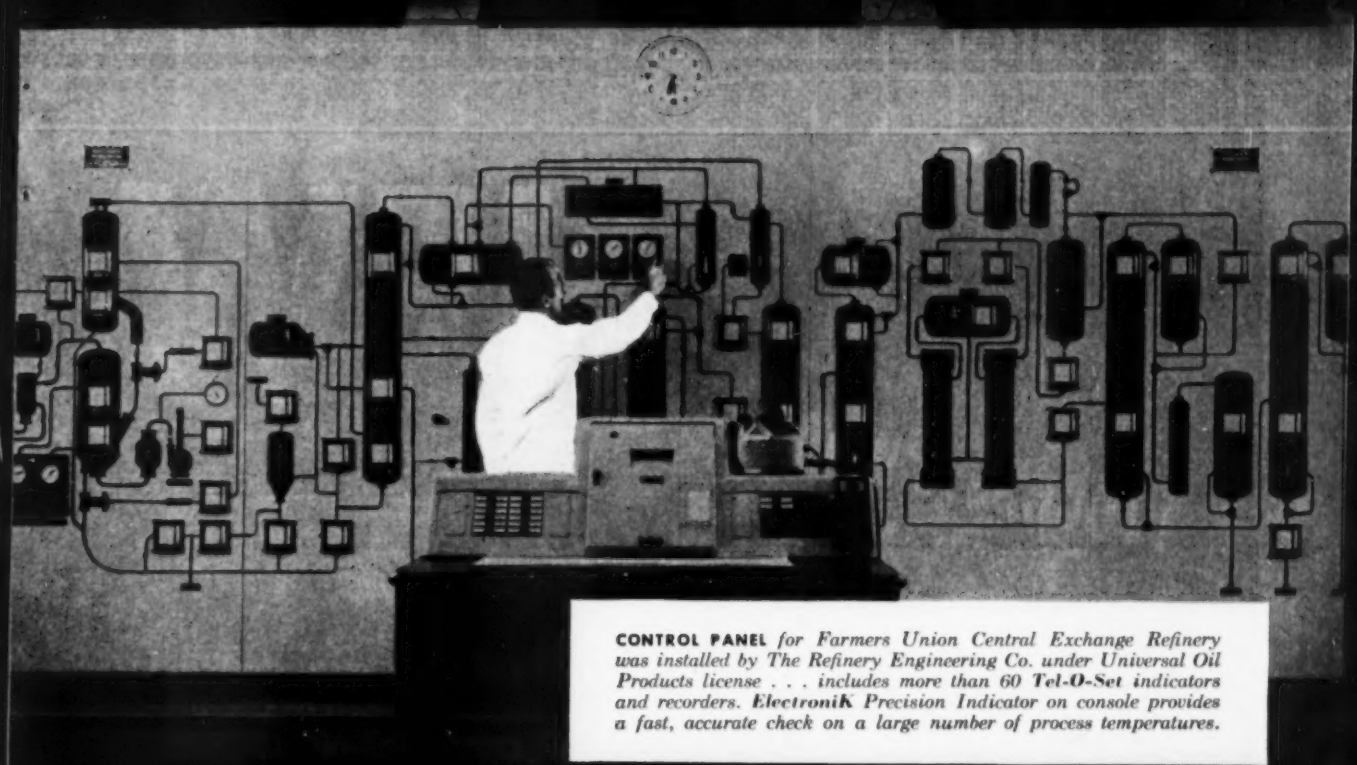
In Honeywell's shop devoted exclusively to panel production, skilled workmen do a complete assembly job. Every instrument, controller and accessory is mounted in place. All back-of-panel wiring and piping is completed, so the board is ready to connect to plant equipment. Before shipment, the entire panel goes through rigorous tests to assure trouble-free installation and start-up when the panel reaches its destination.

# Efficiency-
# *for any*

*Instruments*

*Design*

*Construction*



**CONTROL PANEL** *for Farmers Union Central Exchange Refinery was installed by The Refinery Engineering Co. under Universal Oil Products license . . . includes more than 60* ***Tel-O-Set*** *indicators and recorders.* ***ElectroniK*** *Precision Indicator on console provides a fast, accurate check on a large number of process temperatures.*

# boosting graphic control *refinery, large or small*

THE operating economies of Honeywell centralized graphic instrumentation apply equally well to any refinery—whether it be an independent or one of the biggest producers. Take, for example, the panel shown above. Designed and built by Honeywell for the Farmers Union Central Exchange Refinery at Laurel, Montana, it has every feature of graphic control that advanced design can build into it.

The panel concentrates the operation of a 12,500-barrel-per-day plant, consisting of a fluid catalytic cracker, gas concentration unit and catalytic polymerization unit. *Tel-O-Set* indicators and recorders display every critical process variable for the guidance of operators. Every adjustment for shifting variables is right at the operator's fingertips—an important convenience for plants where market demands change frequently. *Tel-O-Set* controllers behind the panel do the "brainwork" of control—flexibly and accurately—keep all controlled variables accurately in line.

Attractive appearance of the panel aids in reducing operator fatigue . . . simplifies training of personnel. And functional design, both on the front and the back of the panel, speeds installation and service.

Expert design has made Honeywell graphic panels the choice of leading refineries and consultants throughout the world. Your local Honeywell engineering representative will be glad to discuss your own process control in detail . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Bulletin 85-20, "Centralized Instrumentation . . . unlimited."**

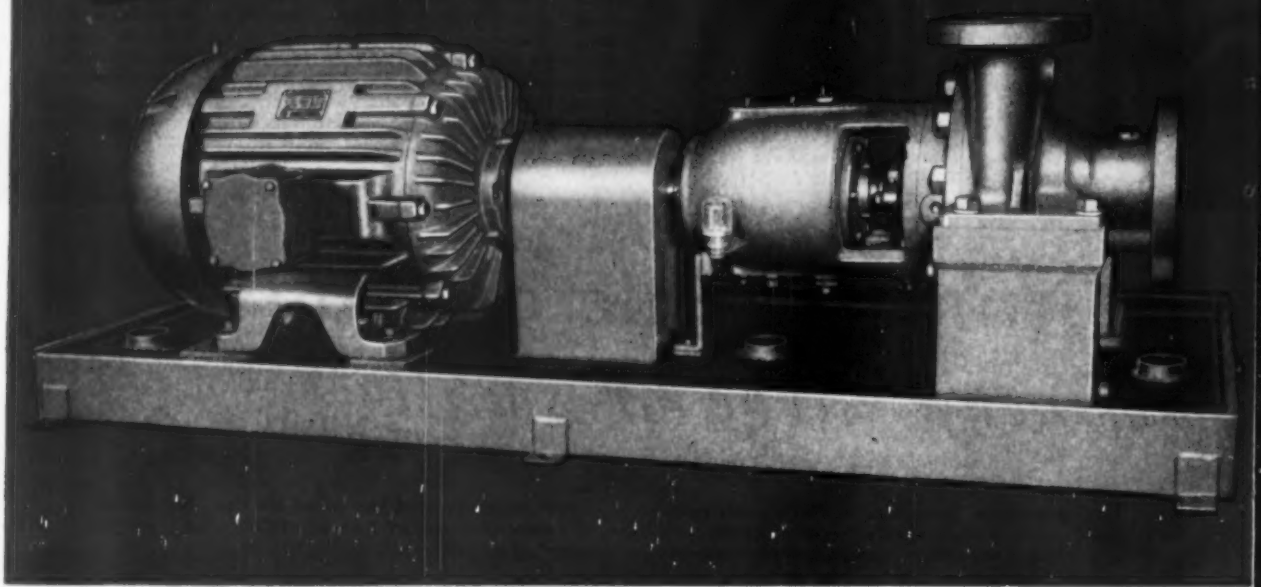
MINNEAPOLIS
**Honeywell**
BROWN INSTRUMENTS
*First in Controls*

# NEW

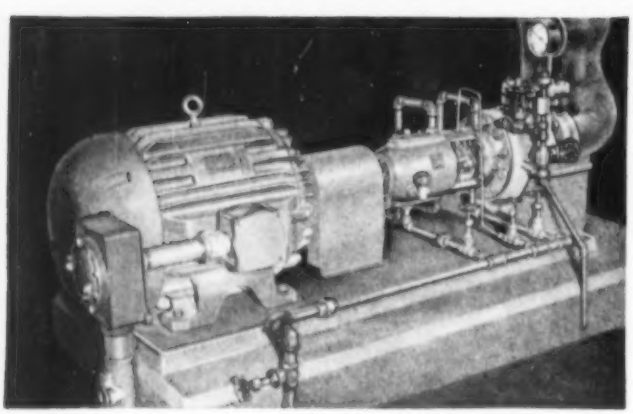
ALLIS-CHALMERS

## Process Pumps

Refinery Type



## *Easy Installation and Maintenance*



All Allis-Chalmers Type R pumps are furnished with spacer-type couplings. This type of coupling permits the pump to be disconnected from the driver and the entire rotating element — bearing bracket, shaft and impeller — removed without disturbing either the piping or the driver. This type of assembly permits quick examination of the pump, simplifies repairs or replacements and keeps downtime of the unit to a minimum.

In addition, two sets of bearing bracket assemblies fit the complete range of pump sizes. Since parts for only two sizes of bearing brackets are required, regardless of the number of pumps operated, parts inventories are greatly reduced. All bearing bracket parts of R-9 pumps are interchangeable and all R-12s are interchangeable. Where continuous operation is vital, a complete spare assembly can be kept on hand and replaced very quickly.

# Refinery Pump

## ☆ Specially designed for high temperature operation

## ☆ Choice of materials and stuffing box arrangements

## ☆ Ample provision for cooling

HERE IS AN ENTIRELY NEW refinery-type pump. It has every feature designed for continuous trouble-free service and to keep your process pumping costs low.

### Sealing Arrangement

When the standard stuffing box is used, it carries an adequate amount of packing plus a seal cage. A mechanical seal is interchangeable with the packing. No machining required. A seal plus auxiliary stuffing box may be installed by simply cutting off the end of the standard stuffing box.

### Cooling Methods

The stuffing box is cooled by a water jacket of ample capacity. Further cooling of the packing is provided by in-and-out connections for the sealing oil, which is thus able to act as a coolant as well as a sealing medium. The stuffing box is provided with a water-flushed smothering gland. A second water jacket surrounds the front bearing and the lower part of the oil reservoir. For extremely high temperature operation, a water-cooled pedestal can be supplied.

### Throat Bushing

A renewable throat bushing is tack-welded on the pump side of the stuffing box. The close clearance between the bushing and the shaft sleeve cuts infiltration into the stuffing box to a minimum. In case of seal or packing failure, the bushing remains in position and will not blow out.

### Wearing Rings

The impeller and casing are both provided with front and rear wearing rings which make it easy and economical to maintain proper clearance. This design also reduces side thrust which in turn reduces shaft deflection and wear.

### Double Volute

Double volute design is used in pumps of more than 400 gpm capacity. Forces set up in one volute are counteracted by equal and opposite forces in the other volute. Deflection forces are greatly reduced.

The impeller has low NPSH requirement so that it will successfully handle high volatile liquids at high temperatures.

### Centerline Mounting

The pump is mounted at the centerline of the casing. Pipe strains are transmitted directly to the foundation. When proper precautions are taken, alignment of rotating parts will not be affected.

### Complete Pumping Unit

Allis-Chalmers can supply a complete pumping unit — pump, motor and control — assembled and ready to install. Coordinated design and manufacture assure undivided responsibility. Call your nearby Allis-Chalmers District Office for help on your next pumping problem. Or write for Bulletin 52B7775. Allis-Chalmers, Milwaukee 1, Wis.

A-4031

# ALLIS-CHALMERS

# TRIFLES?

## Yes...until you need them!

... Then, nine times out of ten, you need them *right* away. That's where your nearest Metal Goods Corporation warehouse comes in. For your convenience, Metal Goods Corporation maintains the largest and widest selection of standard industrial fastenings in the southwest.

If you have an unusual fastening problem requiring individual attention, Metal Goods Corporation can furnish you with "specials", made up in any of the non-ferrous or stainless alloys.

If you need technical assistance in determining which type of fastening is most economical for you to use, Metal Goods Corporation offers you the capable counsel of highly-specialized metal men.

You may also be interested in securing Metal Goods Corporation's new Industrial Fastening Catalog. Engineers and Purchasing Agents who have examined it, say it is one of the most complete and easy-to-use catalogs that they have seen. Would you like a copy? No obligation.

Metal Goods Corporation also stocks most commercial forms of aluminum, brass, copper, monel*, nickel*, inconel*, stainless steel, and steel. When in need of metals or fastenings, call your nearest Metal Goods Corporation warehouse first.

**Please call, wire, or write the Metal Goods Corporation representative nearest you:**

**OFFICES AND WAREHOUSES**

**St. Louis 15, Missouri**
5239 Brown Avenue
Nelson L. Hower
Phone: GOodfellow 1234

**Tulsa 3, Oklahoma**
302 North Boston
Scott J. Harrison
Phone: 4-1175

**Kansas City 16, Mo.**
1300 Burlington
Frank D. Hogan
Phone: NOrclay 3516

**Denver 2, Colorado**
2425 Walnut Street
Neal Dehn
Phone: AComa 5891

**Dallas 9, Texas**
6211 Cedar Springs Rd.
Sam D. Hodgdon
Phone: ELmhurst 3271

**Houston 3, Texas**
711 Milby Street
Harris T. Gregg
Phone: CEntral 8881

**New Orleans 12, La.**
432 Julia Street
Carl T. Wedemeyer
Phone: CAnal 7373

**SALES SERVICE OFFICES**

**Wichita, Kansas**
2200 East Central
Ray Noller
Phone: 7-8921

**Jackson, Mississippi**
781 Raymond Road
George E. Akerberg
Phone: 5-2711

**Baton Rouge, Louisiana**
4419 Mimosa Street
Paul P. Vidovic
Phone: 4-4738

**Omaha, Nebraska**
3515 No. 67th Avenue
C. M. Cooley
Phone: WAlnut 1112

**Memphis, Tennessee**
713 Columbian Mutual Tower Bldg.
Robert W. Downs
Phone: 5-8721

**San Antonio, Texas**
2012 Alamo Natl. Bldg.
Robert E. Reese
Phone: GArfield 3161

**Davenport, Iowa**
924 State Street
Robert L. Tharp
Phone: 2-3156

**Decatur, Illinois**
1305 West Sunset
Arlie W. Tempel
Phone: 8-1314

**Indianapolis 2, Ind.**
1333 N. Pennsylvania
Harry L. Newton
Phone: Lincoln 4980

**Beaumont, Texas**
238 Bowie Bldg.
Lee T. Dodson
Phone: 4-7536, 4-7537

**Fort Worth, Texas**
3821 Carolyn
John M. Turbitt
Phone: FOrtune 4369

**Corpus Christi, Texas**
Room 301-02 Wilson Bldg
Roy D. Bagaley
Phone: 4-0366

**Not stocked in St. Louis or Kansas City Territories.*

**METAL GOODS CORPORATION**

**GENERAL OFFICES: ST. LOUIS 15, MISSOURI**

# HELP NEW Cracking Methods

**Centrifugal Blowers**

**LEFT:** Catalyst lift air blower supplies air at 13,320 cfm, 4.25 psig to raise regenerated catalyst to reactor. Kiln combustion air blower is seen to the rear.

**ABOVE:** Carbon is burned off the catalyst while air is supplied at 34,400 cfm, 3.5 psig by this kiln combustion air centrifugal blower.

AS CRACKING METHODS IMPROVE, more centrifugal blowers are being employed. The Allis-Chalmers single stage blowers seen here are essential to the three new Thermofor Catalytic Cracking units installed by the Magnolia Petroleum Co. at Beaumont, Texas.

A total of six turbine-driven A-C single stage blowers provide kiln combustion and catalyst lift air in the blower room of the new catalytic structure.

The high efficiency impellers are of special totally enclosed, backward flow design. This covered design makes the impellers independent of tolerance variations; the backward flow design gives good pressure, volume and horsepower characteristics.

High strength and long life is assured by all-welded, alloy steel impeller construction and pressure lubricated sleeve and thrust bearings. Cast iron casing increases rigidity and decreases noise level.

For this kind of specialized design . . . or for standard high quality, thoroughly tested air and gas handling equipment . . . call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wis.

A-3999

Texrope is an Allis-Chalmers trademark.

**ALLIS-CHALMERS** AC

**Power, Electrical, Processing Equipment for Petroleum Industry**

TURBINE-GENERATORS | BLOWERS and COMPRESSORS | TRANSFORMERS | UNIT SUBSTATIONS | MOTORS—TEXROPE DRIVES-CONTROL | CENTRIFUGAL PUMPS

# Guaranteed G-R Results

*with the new*

# G-R fin-fan*

## AIR-COOLED HEAT EXCHANGER

* *Improved design*
* *Wide application*
* *Dependable service*

**WRITE FOR DETAILS**

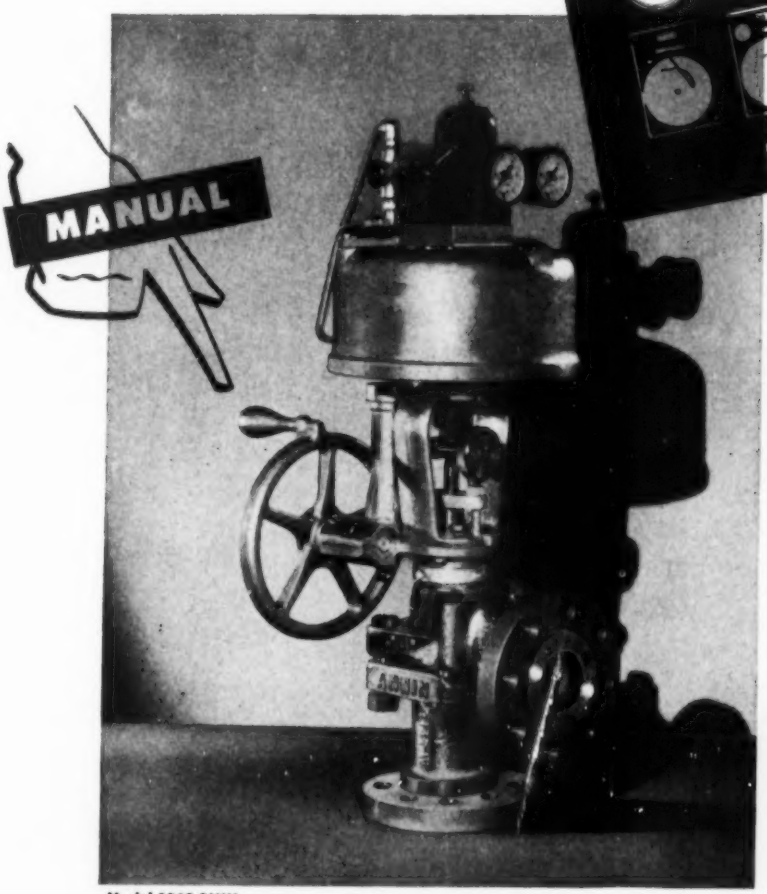
*Designed, manufactured and serviced by*

**THE GRISCOM RUSSELL CO. · MASSILLON, OHIO**

GR-316

# VERSATILITY *plus!*

## COMBINATION OF AUTOMATIC-MANUAL OPERATION INCREASES FLEXIBILITY OF ANNIN VALVES...

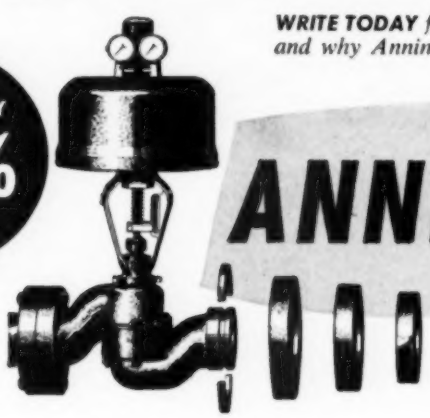



Model 1560 SMW

To ANNIN's powerful Domotor automatic operation add the versatility of a side-mounted Handwheel. This combination provides the answer to field demands for convenient and positive *supplementary* control during start-up periods, or when the system is shut down temporarily for instrument repair. The Handwheel can act to operate the valve manually and provides an adjustable limit stop in either the opening or closing direction. This auxiliary manual control is particularly advantageous in adjusting the minimum or maximum flow of steam to turbines, steam engines and other process equipment. Further evidence of the increased utilization, simplicity of design and greater economy of ANNIN VALVES.

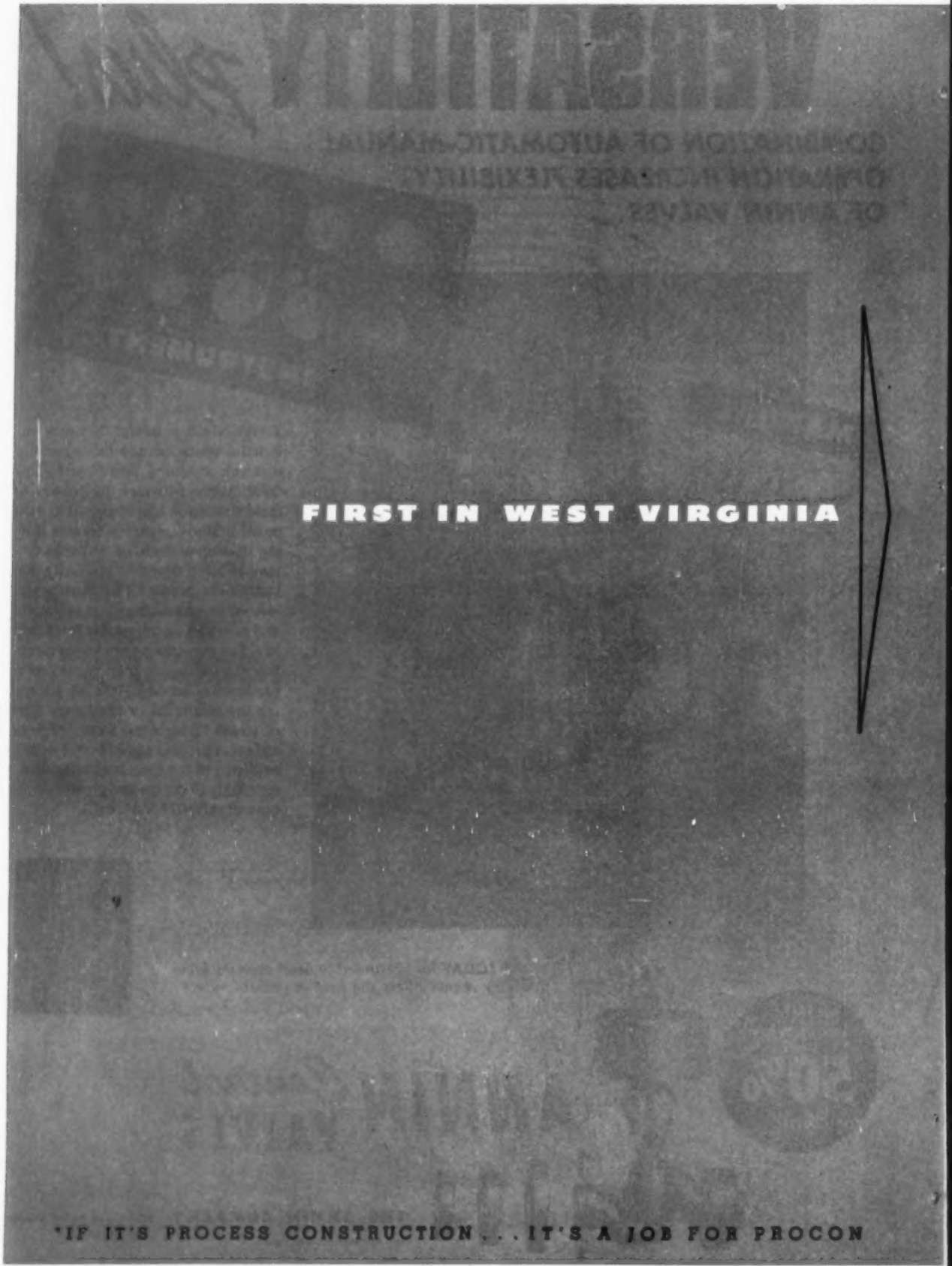
***WRITE TODAY** for illustrated bulletin showing how and why Annin offers the best in control valves.*

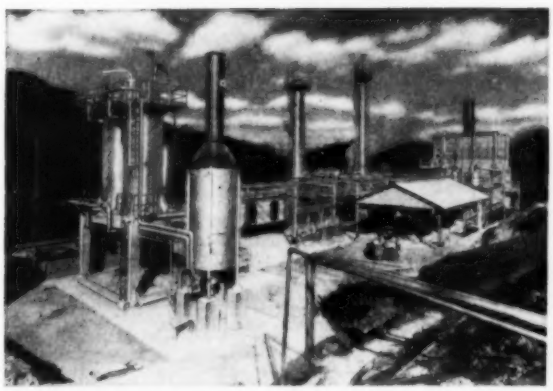
CUT INVENTORY 50% WITH



**ANNIN** *Control* **VALVES**

**THE ANNIN COMPANY** 3500 Union Pacific Avenue
Los Angeles 23, California


FIRST IN WEST VIRGINIA
"IF IT'S PROCESS CONSTRUCTION . . . IT'S A JOB FOR PROCON



## PLATFORMING UNIT BUILT BY PROCON FOR ELK REFINING CO.

A new Procon-built UOP Platforming unit is successfully operating at the Falling Rock refinery of Elk Refining Company. This new unit — the first in West Virginia — is the latest addition to the growing list of processing facilities constructed by Procon and now operating in refineries of both major and independent companies . . . another example of Procon success in handling a broad range of jobs throughout the nation and overseas.

**PROCON** *Incorporated*
**PROCESS CONSTRUCTION**
1111 MT. PROSPECT ROAD, DES PLAINES, ILL., U. S. A.

IN ENGLAND
**PROCON** (*Great Britain*)
LIMITED
112 STRAND, LONDON, W. C. 2

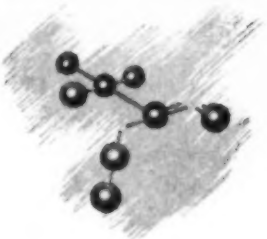
## ...two reliable names along the path of petroleum processing

**WHAT DO YOU WANT TO PURIFY?**

There's an Attapulgus or Porocel adsorbent to fit your process technique for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from process liquids or gases. Materials treated in principal applications are: motor oils and other lubricating, specialty, and technical oils; petrolatums and waxes; aviation and motor gasoline stocks; kerosene; diesel and heating oils.

**DO YOU HAVE CATALYST OR CATALYST CARRIER NEEDS?**

Attapulgus or Porocel sorptive minerals are recognized standards in desulfurization, reforming and isomerization systems—catalytic removal of unsaturates—conversion of sulfides to elemental sulfur—fluid catalyst applications—as catalyst carrier in copper sweetening processes.

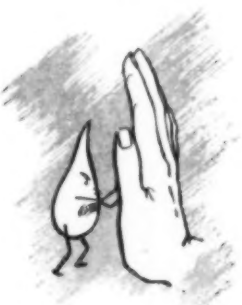


**WHAT DO YOU WANT TO DRY?**

We offer a wide range of reliable, thoroughly proved desiccants for drying air, hydrogen, carbon dioxide, hydrocarbon liquids and gases.

**SPECIAL GRADES?**

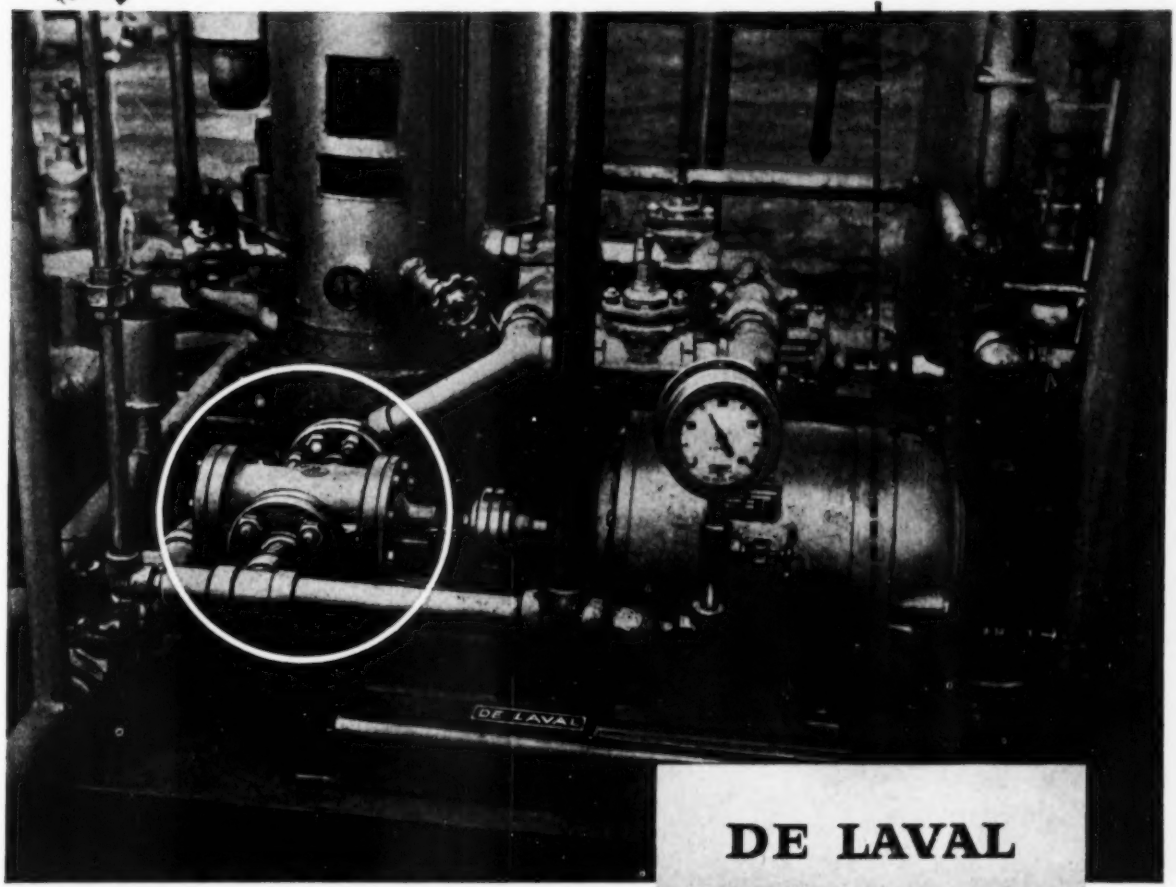
Mine and plant facilities permit prompt and economical production of grades meeting individual customer specifications. Our laboratories and technical staffs welcome the opportunity of assisting in research, development, design and operating problems. Your inquiries are invited.



**ATTAPULGUS** MINERALS & CHEMICALS CORPORATION · **POROCEL** CORPORATION

Dept. W, 210 West Washington Square, Philadelphia 5, Pa.

# *Versatile pumps for refinery service*




*De Laval-IMO pump in service in midwest packaged gasoline plant.*

**DE LAVAL**

**IMO PUMPS**

Today, De Laval-IMO rotary pumps are proving their versatility in dozens of refinery applications. These dependable pumps are being used in refineries and bulk plants to handle viscous fluids including fuel oils, heavy crude oils, lubricating oils and asphalt, as well as the lighter hydrocarbons. For example:

*An eastern refinery* installed an IMO to pump *viscous* oil at 550 psi. Performance was so satisfactory that three more IMO units were ordered within a few weeks.

*A midwest refinery* is using De Laval-IMO pumps to handle *asphalt* at 470F at 922 psi and *petrolatum* at 420F and 575 psi.

*For a new tank field* distribution system, another refinery has 58 direct-connected 1150 to 1750 rpm IMO pumps, handling various oils with viscosities up to 3600 SSU, capacities to 200 gpm and pressures to 150 psi.

The unique IMO design—*with only three moving parts* — assures long, trouble-free performance. IMO pumps are quiet, pulsation-free, compact and designed for direct-connected high-speed operation. Send for Bulletin LG showing wide range IMO line for capacities to 1,000 gpm at pressures to 500 psi and for capacities to 150 gpm at pressures to 1,500 psi.

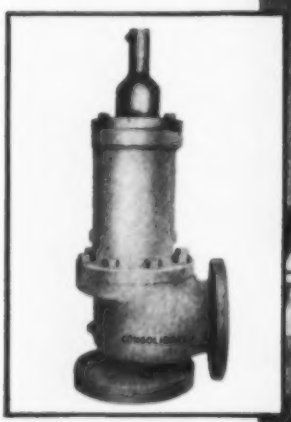
**DE LAVAL** *IMO Pumps*

**DE LAVAL STEAM TURBINE COMPANY**

*811* ***Nottingham Way, Trenton 2, New Jersey***

DL 181

# ALWAYS ALERT TO DANGER . . .



## CONSOLIDATED SAFETY RELIEF VALVES

The hazards of uncontrolled overpressures are easy to avoid. Consolidated Safety Relief Valves assure *absolute protection* for personnel, plant and processing equipment. They don't leak under discharge piping stresses because their design incorporates outside bevel seat and floating guide construction. The disc seats on a radial seating surface — dependable tightness is assured in all positions within the deflection range. Unfired pressure vessels — gas, vapor, and liquid storage tanks, pipelines, pumps — are dependably safeguarded against overpressures, even in the severest services.

Consolidated Safety Relief Valves have 25% fewer parts than ordinary valves of their type. Naturally, maintenance problems are greatly reduced and service life is increased, while standardization is simplified. Materials of the highest quality, precision workmanship and rigid tests assure continuously reliable performance at the rated capacity. Full information is yours on request.

**YOUR INDUSTRIAL SUPPLY DISTRIBUTOR** has all kinds of experience in meeting the most exacting requirements of the processing industries. You can count on his ability, knowledge and facilities for the best in products and service. Phone or write him today.

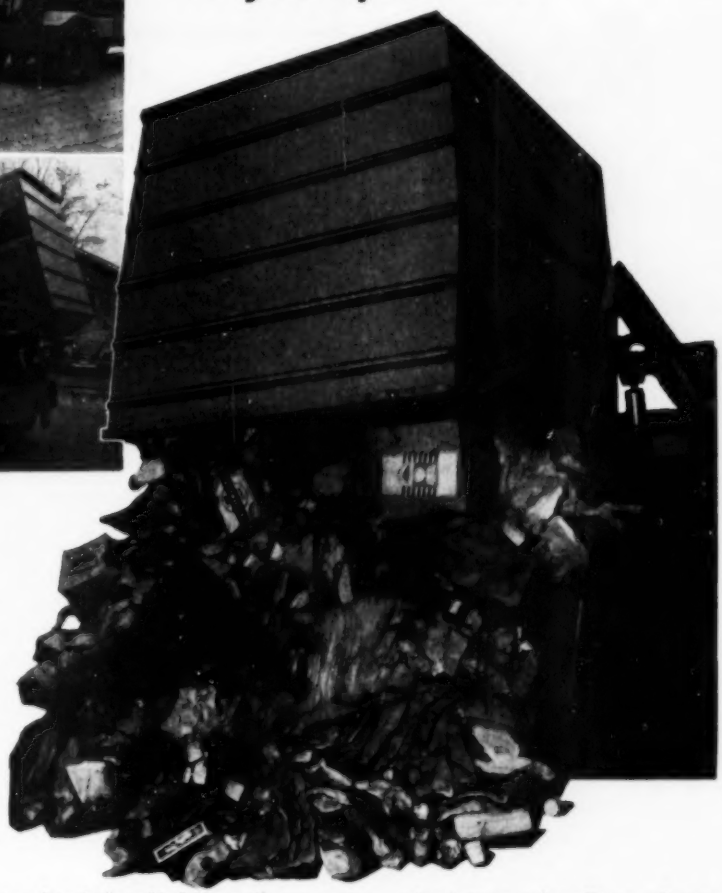
1879 CONSOLIDATED U.S.A.

**CONSOLIDATED SAFETY RELIEF VALVES**

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

# Rubbish Disposal is only ONE of the Cost Cutting jobs for the Dempster-Dumpster in your plant...



It's amazing, almost to the point of fantasy, yet so soundly real, what the minds of men in all types of industry have cooked up for more efficiency and reduced costs with the Dempster-Dumpster.

Hundreds of plants are handling materials of practically every description with one truck-mounted Dempster-Dumpster serving scores of detachable containers. Here are just a few. Oils, gases, and liquids handled in our Tank Type Containers . . . tools and equipment in our Tool Shed Type Container . . . containers on casters placed for receiving steel chips from lathes or at conveyors for receiving finished products . . . container with doors and windows, replacing shacks for plant guards or nightwatchmen . . . containers built to handle chlorinator ash residue of approximately 1500° F. and there are dozens more.

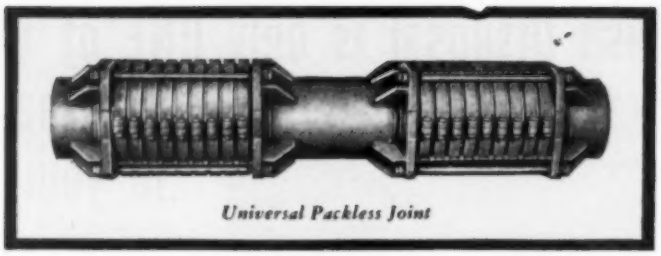
Containers are placed wherever material accumulates. When loaded each is picked-up, hauled and emptied (as illustrated above) . . . or load set down intact. The entire operation is handled by only one man, the driver, by hydraulic controls in cab.

The containers are built in capacities up to 12 cu. yds. and each is designed to suit the materials to be handled—be they bulky, light or heavy . . . solids, liquids or dust.

One Dempster-Dumpster, with driver, does the work of 3 to 5 conventional trucks . . . eliminates trucks and crews standing idle . . . eliminates rehandling of materials and increases efficiency and good plantkeeping.

If you have even any remote idea that this equipment could be adapted to your operation, by all means contact us because being without the Dempster-Dumpster System could easily be costing your company thousands of dollars annually. Manufactured and sold exclusively by Dempster Brothers, Inc.

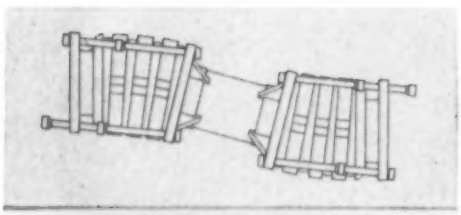
**DEMPSTER BROTHERS, 553 Dempster Bldg., Knoxville 17, Tennessee**



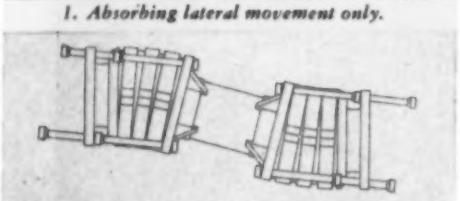
*Universal Packless Joint*

# ADSCO Joint

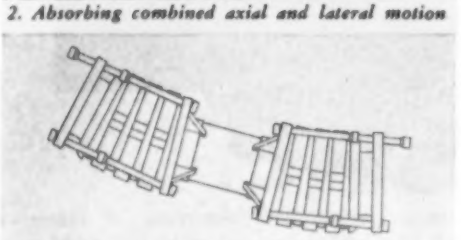
# ...THE UNIVERSAL FAVORITE



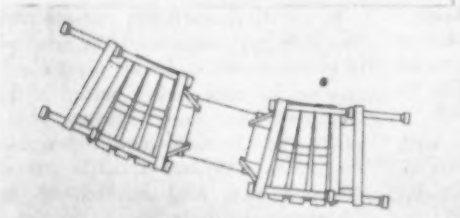
*1. Absorbing lateral movement only.*



*2. Absorbing combined axial and lateral motion*



*3. Angular rotation without axial motion.*



*4. Combined angular and axial motion.*

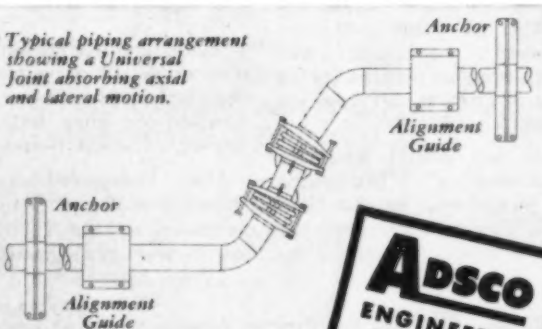
● When it comes to expansion joints, ADSCO is the universal favorite because ADSCO — and only ADSCO — makes a complete line of joints, both slip and packless.

And if your problem is to absorb pipe line movement in all planes simultaneously, ADSCO Universal Packless Joints are the favorite . . . Often it is impossible or impractical to eliminate lateral motion or to isolate lateral from axial motion by anchors and guides. In these circumstances, the Universal Joint will reduce the number of anchors required and consequently reduce the amount of steel work necessary to support them. In Drawing 1 at the left, the Universal Joint is shown absorbing lateral movement only. By lengthening the intermediate pipe nipple the amount of lateral movement can be increased without increasing the number of corrugations. In Drawing 2, the same joint is absorbing combined axial and lateral motion. Drawing 3 illustrates the joint in angular rotation without axial motion. Drawing 4 shows combined angular and axial motion.

ADSCO can solve *any* of your pipe expansion problems. Call your ADSCO representative or write for Bulletin 35-51A.

*● For best results, use ADSCO Pipe Alignment Guides.*

*● Typical piping arrangement showing a Universal Joint absorbing axial and lateral motion.*




ADSCO ENGINEERED PRODUCTS

EXPANSION JOINTS • HEAT EXCHANGERS • STEAM TRAPS • STRAINERS • SEPARATORS • METERS

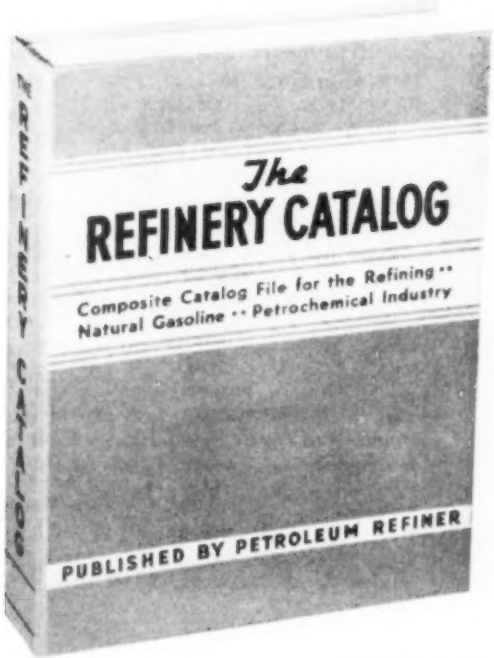
## AMERICAN DISTRICT STEAM COMPANY, INC.

NORTH TONAWANDA, NEW YORK

*Since 1877*

# Starting a New Project?

Refinery Catalog has complete data on equipment and services for the Refining Industry.


The
REFINERY CATALOG
Composite Catalog File for the Refining •• Natural Gasoline •• Petrochemical Industry
PUBLISHED BY PETROLEUM REFINER

Reach for your Refinery Catalog whenever you're planning a project. Turn to the easy-to-use index and you'll find that most of the known manufacturers have data filed in this universal equipment buyers guide. The 1953 edition carries catalog information on products and services offered by more than 300 manufacturers.

No wonder Refinery Catalog is used as the preferred source of catalog information among refiners the world over. Remember—look for it *first* in the *Refinery Catalog*.

**THE UNIVERSAL EQUIPMENT GUIDE FOR REFINERY BUYERS**

## REFINERY CATALOG

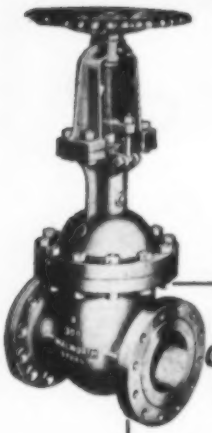
**P. O. BOX 2608 • HOUSTON 1, TEXAS**

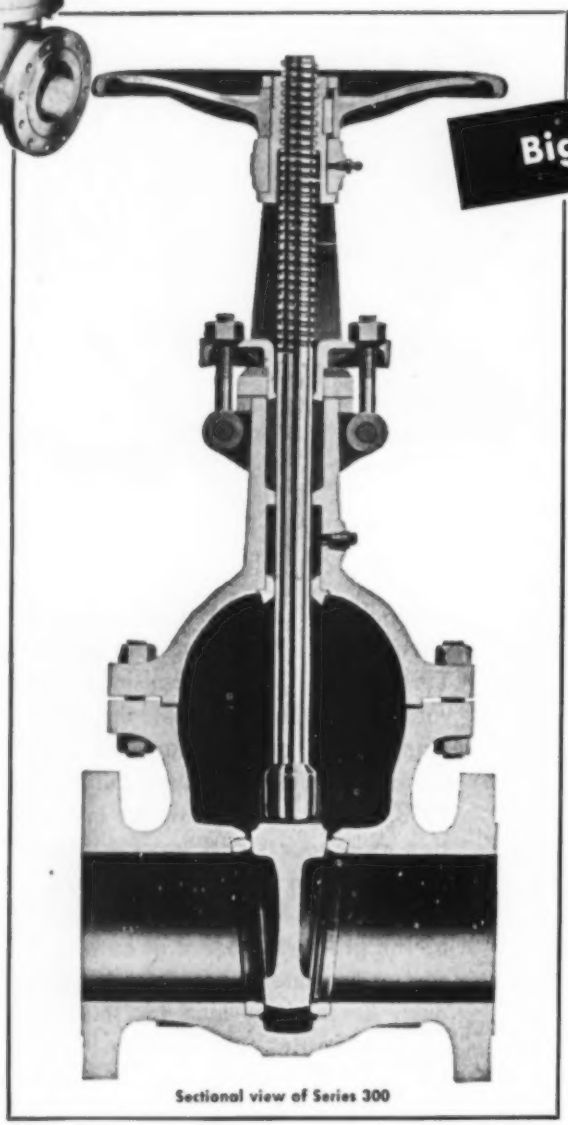
**WALWORTH**

# Cast Steel Gate Valves

***Series 150 and 300***

***Wedge Gate — Outside Screw and Yoke***





Sectional view of Series 300

**Big 8-Point Superiority!**

**Gland** clearances are such that stem cannot be scored if gland should be tightened unevenly.

**Deep Stuffing Boxes** in all sizes (2″ to 24″) insure tightness and maximum packing life – costly leaks are eliminated.

**Bonnets and Bodies** are engineered to withstand pressure and minimize distortion – they're tough, durable, dependable.

**Heavy Steel Walls** provide extra strength and longer life.

**Integral Body Guide Rib Faces** are machined to insure accurate disc seating.

**Seat Rings** are bottom seated – not flange type. No recess exists at back of ring – hence no turbulence, erosion, or pressure drop.

**Streamlined Ports** allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

**Valves** regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

***For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.***

For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

**WALWORTH**

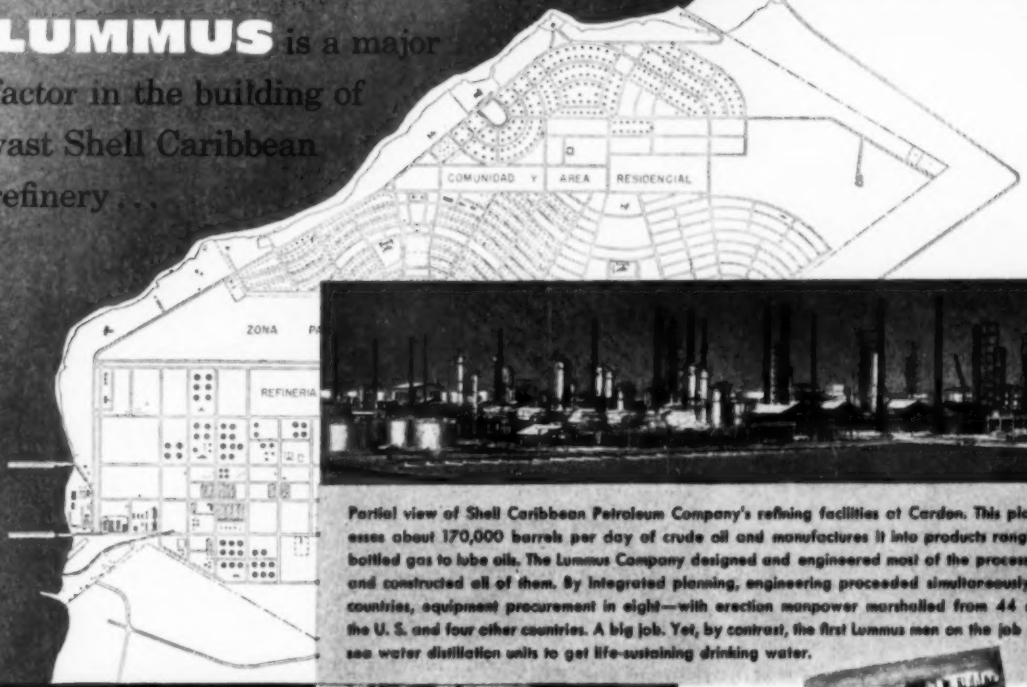
**valves and fittings**

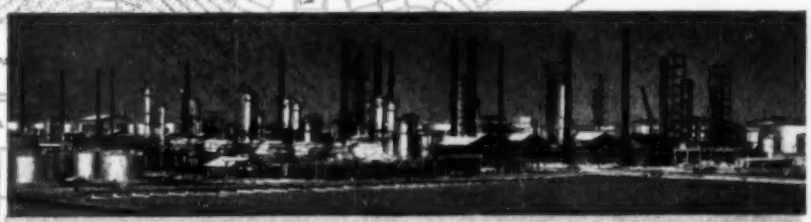
**60 EAST 42nd STREET, NEW YORK 17, N. Y.**

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

# 3150 acres of new "plant life" on remote Venezuelan cape...

**LUMMUS** is a major factor in the building of vast Shell Caribbean refinery...



Partial view of Shell Caribbean Petroleum Company's refining facilities at Cardon. This plant processes about 170,000 barrels per day of crude oil and manufactures it into products ranging from bottled gas to lube oils. The Lummus Company designed and engineered most of the processing units and constructed all of them. By integrated planning, engineering proceeded simultaneously in four countries, equipment procurement in eight—with erection manpower marshalled from 44 states in the U. S. and four other countries. A big job. Yet, by contrast, the first Lummus men on the job installed sea water distillation units to get life-sustaining drinking water.

Cardon's Two Stage Atmospheric and Vacuum Distillation Unit No. 1 (shown here), and its two companion "stills", represent high development of the distillation art. Designed and built by Lummus, these basic plants are characterized by wide flexibility and closely controlled quality of fractionated products. Cardon is also the home of Venezuela's first lubricating oil plant—another in a long list of "firsts" for Lummus in the lube oil field.

Here is good international construction policy (and project economy) in operation. These Venezuelans, rigging a six-sheave block to hoist a 100-ton tower, became adept at erection skills under Lummus' field training system. During the construction period at the Cardon site, key Lummus men also taught welding, pipefitting, maintenance and repair to many local workers; operated a rock quarry, batch concrete and concrete block plants.

Just Off Press... our newest picture brochure, "New Horizons—Lummus at Cardon." Twenty-four pages covering this world-famous plant. May we send you a free copy? Just drop us a line at Room 359, 385 Madison Avenue, New York 17.

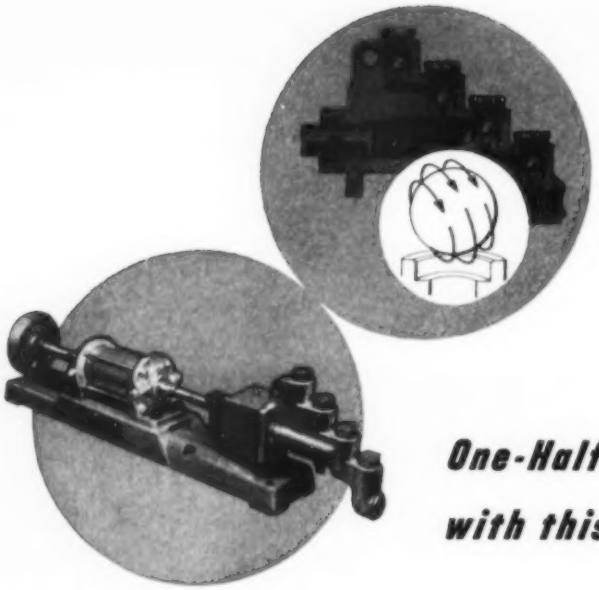
Shell-Cardon is a good example of why the Lummus name is well known in the petroleum, petrochemical and chemical fields—and respected for the ability to get big, tough jobs completed rapidly and economically.

**THE LUMMUS COMPANY**

385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



Basic design simplicity of the *exclusive* Milton Roy liquid end step-valve assures high and reproducible volumetric efficiency. Self-cleaning *double* ball-checks spin any lodged particle free, are non-clogging, seat positively.

# *One-Half of One Per Cent Accuracy with this Milton Roy Pump*

CONTROLLED VOLUME PUMPING

INSTRUMENTATION

PROCESS CONTROL SYSTEMS

BLENDING AND FORMULATING

ON THE JOB in a leading processing plant, two of these air-powered controlled volume pumps meter deionized water solution from a chemical proportioning system to a key production process. Data obtained from *one full year* of operation showed a pumping accuracy within ½ of one per cent!

This is a typical Milton Roy Pump—one of many types of air-powered or motor-driven positive displacement pumps—in daily use in hundreds of similar operations. In *chemical processing*, for example, they're used in fermentation, pH control, hydrogenation of fatty acids. In the *textile and paper fields*, for resin impregnations, peroxide saturates, finish liquors. In *metals and mining*, for plating solution recovery, ore flotation, diatomaceous earth slurry handling. Wide as industry itself, the application of these pumps gives dollar savings not only in accuracy, but in longer service life and man-hours saved. These pumps meter practically any liquid in capacities from 3 milliliters per *hour* to 45 gallons per *minute* against pressures ranging to 25,000 pounds per square inch. They are available as single or multiple units, or as component parts of complete chemical feed and control systems.

***Bulletin No. 351*** *gives you facts on Milton Roy* ***Air-Powered Controlled Volume Pumps*** *and their application. Write,* ***now,*** *for your* ***free*** *copy*

MILTON Roy COMPANY

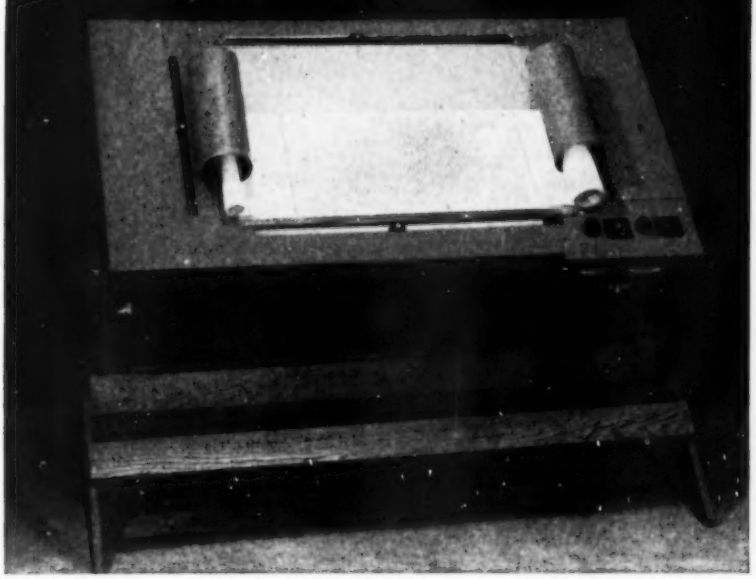
*Manufacturing Engineers* • 1315 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

*Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.*

*Telecomputing presents still another advance in automatic data reduction...*

# The CONTACT TELEREADER MEASURES RECORDS WITH GREATER FLEXIBILITY



**Flexible in output:**

Visual (no companion equipment needed).

Analog Voltage (when used with potentiometer and voltage source).

Digital (when used with Reading Heads Type 15A and Telecordex Type 8A or when used with potentiometer and Teleducer Type 24A).

**Flexible in operation:**

Handles single sheet or roll records—any width up to 18" and any length.

Height and angle of viewing screen may be adjusted for greater ease of operation.

Combines rapid cross-wire motion with precise measurements.

All methods of readout may be referenced to any zero point on viewing screen.

**Flexible in application:**

Edits.

Reads records.

Performs linear and non-linear calibrations.

Serves as an integral part of several types of data reduction systems.

**In addition, the Contact Telereader offers these important advantages:**

Low cost

Large, unobstructed viewing screen (18"x 30")

Accuracy to .01" per count

No parallax problem

Fast, easy to set-up

Simplicity of operation

Contact Telereader Technical Bulletin 105 will be mailed you upon request. Coupon below is for your convenience.

**TELECOMPUTING**

**CORPORATION**

**BURBANK, CALIFORNIA**

*Turn hours into minutes with automatic data reduction*

Mr. Preston W. Simms, PR-5
Telecomputing Corporation, Burbank, California

Please send me CONTACT TELEREADER Technical Bulletin 105.

Name

Company

Street Address City and State

# WOLVERINE TUBING

## *Plain*

Wolverine tube possesses the greatest measure of *long-life-quality* that expert skill and years of experience can ever put into any tube.

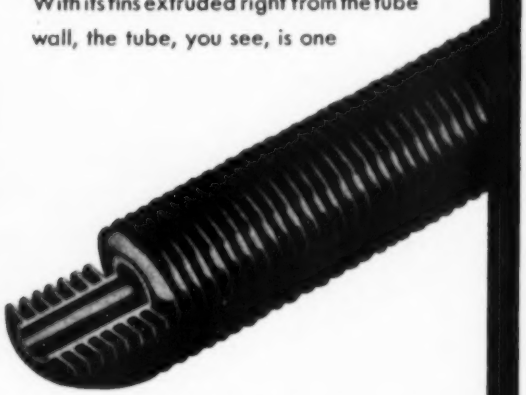
And to make sure you will ultimately realize from your installation all the potential that Wolverine tube can supply, we suggest you ask our Customer Engineering Service to give you further assistance in the selection of tube of the proper alloys that will best meet your particular operating conditions.

Some of the most popular alloys: copper, cupro-nickel, brass, red brass, 70-30 brass, Muntz metal, aluminum and electric welded steel.

# WOLVERINE TRUFIN*

## *Finned*

Trufin is a unique finned tube distinguished by its integral fin construction. With its fins extruded right from the tube wall, the tube, you see, is one



piece of metal, and consequently cannot be affected by vibrations or sudden temperature changes.

Nominal sizes range from ⅜" to ¾" root diameter. Furnished with thick-walled plain ends to permit best assembly.

Alloys available: copper, cupro-nickel, red brass, admiralty, aluminum, aluminum-brass, SAE 1010 steel, and stainless steel.

*REG. U.S. PAT. OFF.

*Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.*

When you attend the Inform-A-Show in Los Angeles, May 24-27, be sure to visit our Booth 304

**WOLVERINE TUBE DIVISION**
of CALUMET & HECLA, INC.
*Manufacturers of Tubing Exclusively*
1431 CENTRAL AVENUE • DETROIT 9, MICHIGAN
Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

ESTABLISHED 1916

# To know how good valves can be, install valves that are known to be good

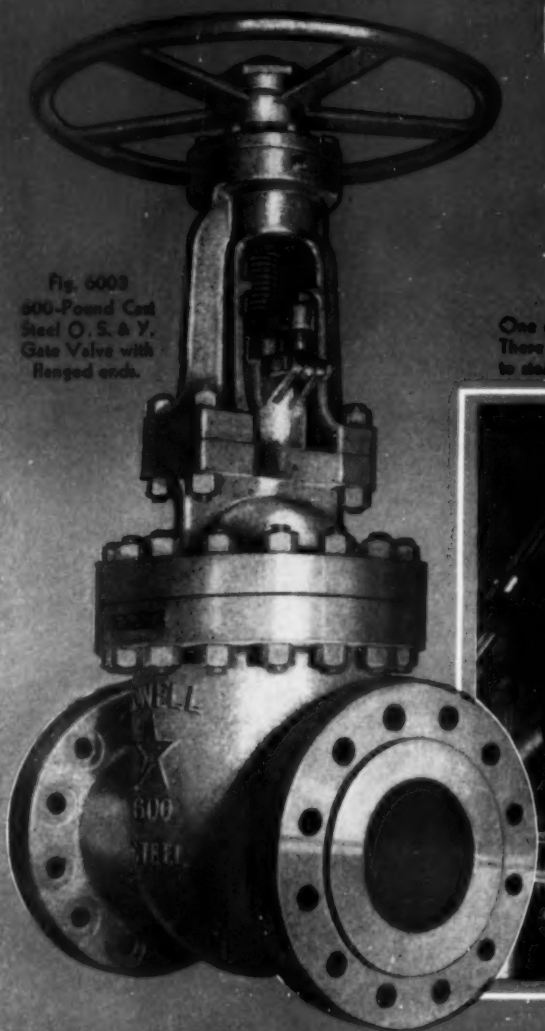
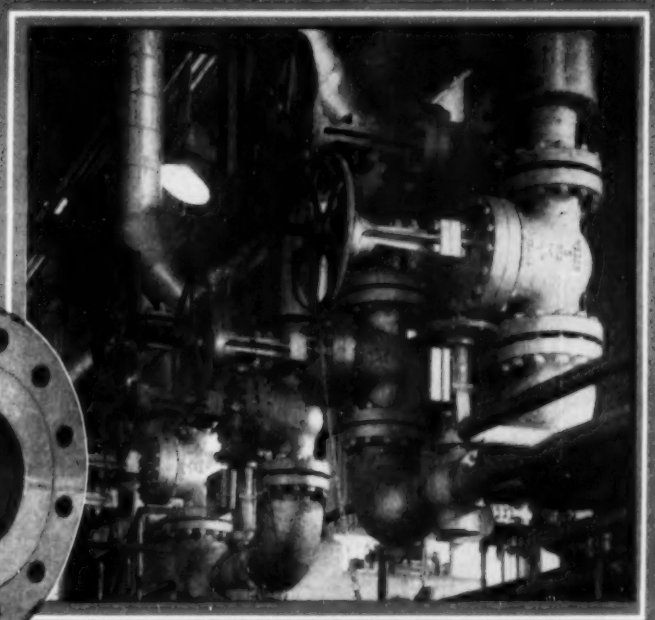



Fig. 6003
600-Pound Cast Steel O. S. & Y. Gate Valve with flanged ends.

**Powell Valves are known to be good in every branch of the Petroleum Industry. That's why you find them in the leading oil and gas plants of the country.**

**The Wm. Powell Company**
**Cincinnati 22, Ohio**

One of the Powell installations in the El Paso Natural Gas Co. plant. These are 600-pound cast steel gate valves in steam lines from boiler to steam turbines driving generators in gas treating plant.



# POWELL

DEPENDABLE VALVES SINCE 1846

**BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES**

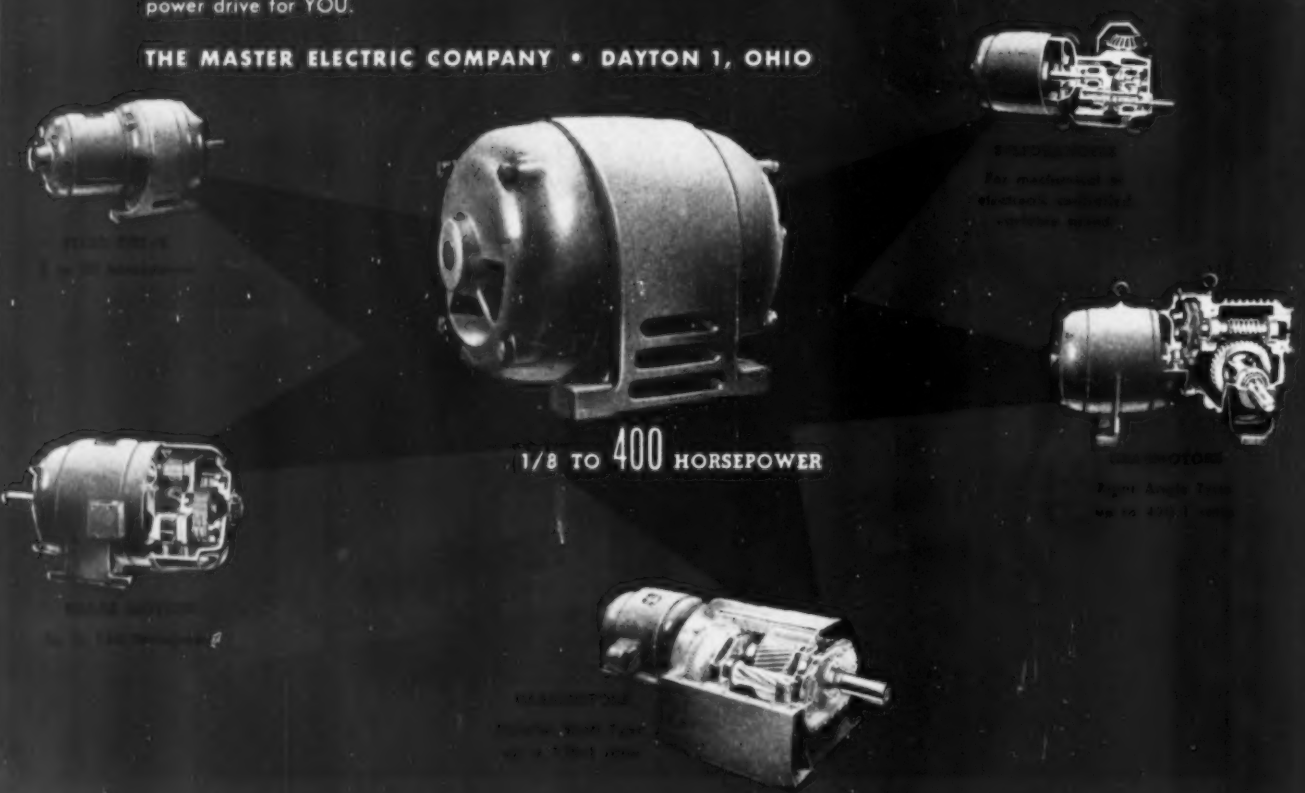
Whenever you select a power unit, don't put a straight-jacket on your ideas . . . consider ALL of the possibilities of modern power drives.

For example consider the many useful combinations that can be secured with the basic Master power units shown below. They're designed so they can be easily combined together to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features in one compact unit that you can use RIGHT where you want it. Nowhere else will you find power units that are so flexible, so easily adaptable, and in such a wide range of types and ratings.

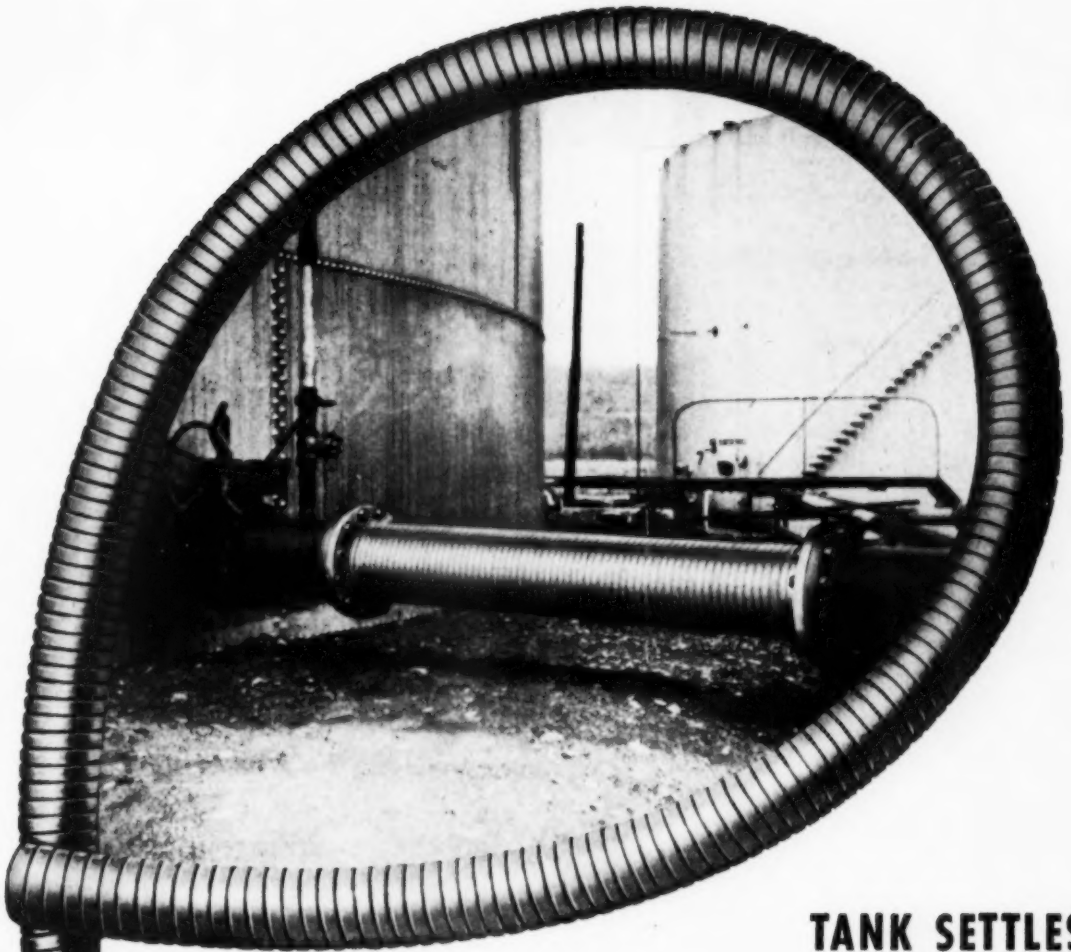
Master power drives are available in thousands and thousands of ratings ( ⅛ to 400 HP) . . . in open, enclosed, splash proof, fan cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 430 to 1 ratio . . . with electric brakes . . . with fluid-drive . . . with mechanical or electronic variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best power drive for YOU.

**THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO**

# give your brains a chance



1/8 TO 400 HORSEPOWER



## TANK SETTLES...

## PIPE WALKS... BREAK AVOIDED WITH PENFLEX

Tank settlement . . . thermal expansion and contraction caused misalignment of pipe and the consequent breakage of rigid pipe connections on large oil storage tanks. Oil and gasoline was lost . . . a fire hazard was ever present. The answer was offered by Penflex engineers.

Today, this large New England storage center has no trouble with pipe breakage. A length of 12" I.D., four-wall interlocked specially packed Penflex tubing was installed with tight-packed flanges. No amount of settling of the tank or thermal expansion causes breakage of connections. The easy flexing Penflex "walks" with the tank . . . yet maintains a tight leak-proof connection at all times. Leakage has been eliminated . . . fire hazard reduced.

Let Penflex engineers help you on flexible tubing application problems. Penflex manufacturers a complete line of four wall, interlocking and seamless welded corrugated flexible tubing . . . metallic hose, tubing or couplings from ⅛" I.D. and up . . . automatic barrel fillers, pneumatic rivet passers, accessories and fittings. Write for folder "Flexineering," a valuable production aid.

**Pennsylvania Flexible Metallic Tubing Company, Inc., 7207 Powers Lane, Phila. 42, Pa.**
***Branch Sales Offices:*** **Boston • New York • Chicago • Houston • Cleveland • Los Angeles**

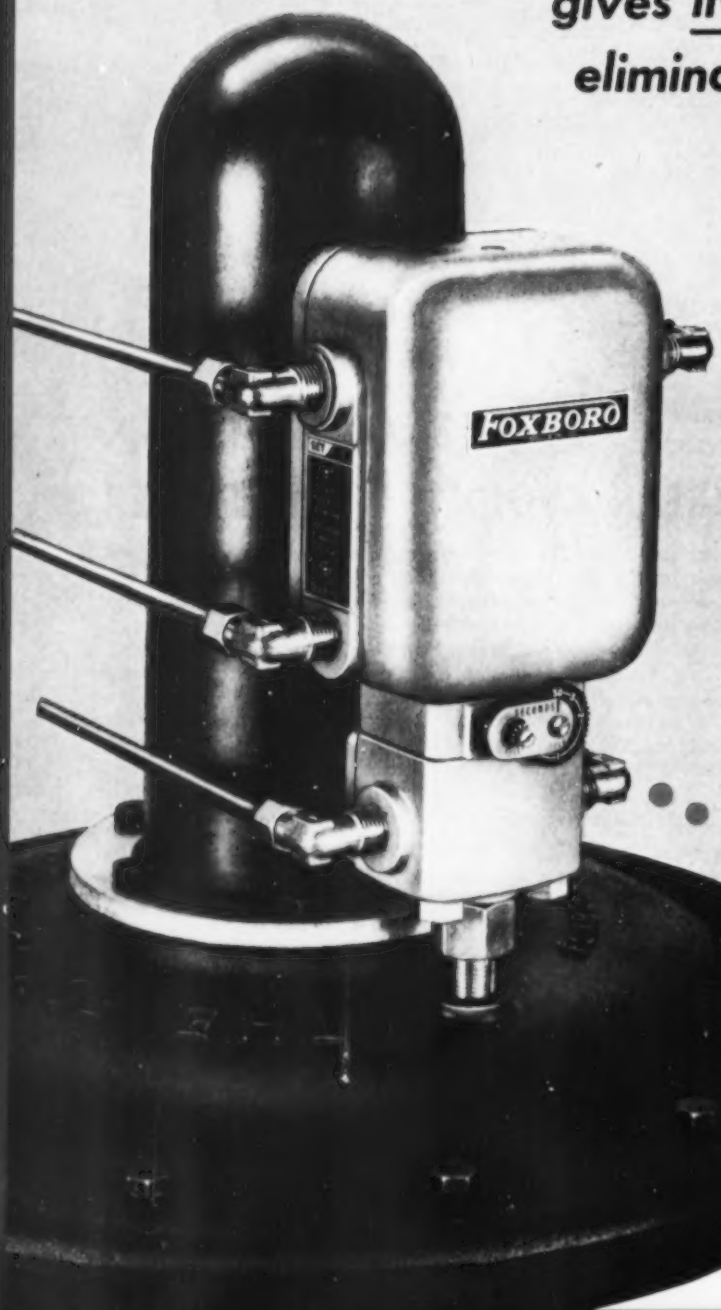
# penflex

**HEART OF INDUSTRY'S LIFE LINES**

# NOW CONTROL FLOW

## M/59 Consotrol Controller

### *gives live-balance sensitivity, eliminates transmission lag.*

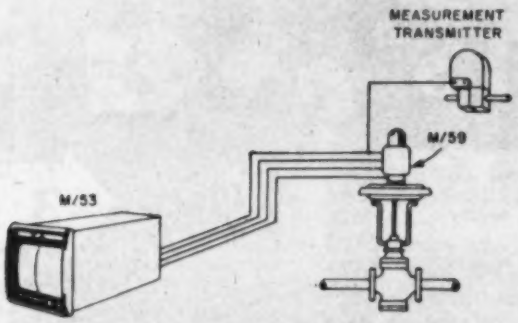



Designed specifically for *dynamic* control of flow, the M/59 Consotrol Controller takes full advantage of the speed and sensitivity of the Foxboro d/p Cell (flow transmitter). It is the direct result of Foxboro basic research into today's flow control problems.

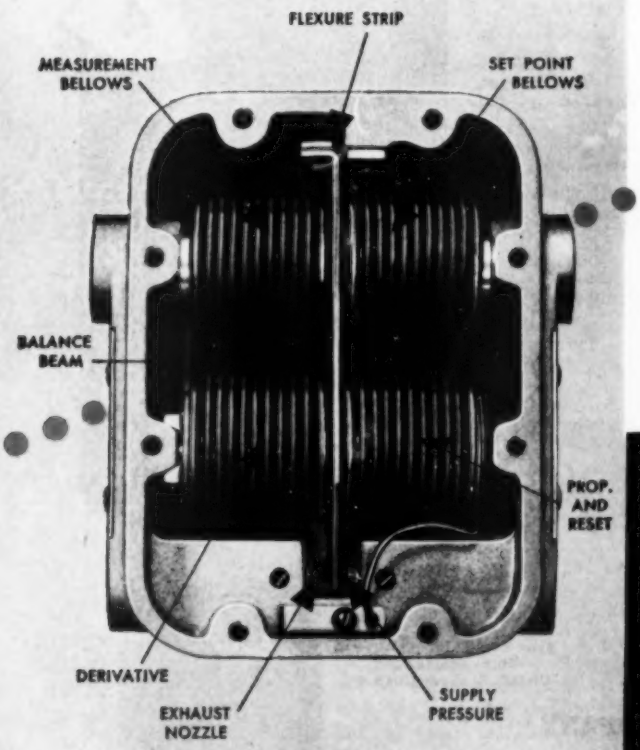
This revolutionary flow controller combines inherently dynamic action with unique simplicity of design. Mounts directly on valve — no transmission line, no lag!

Write for Bulletin 470 which fully describes this outstanding development in flow instrumentation. The Foxboro Company, 745 Neponset Ave., Foxboro, Mass., U.S.A.

# DYNAMICALLY




**Schematic diagram shows the M/59 Controller as installed in conjunction with Foxboro d/p Cell and M/53 Consotrol Recorder.**




- **Valve Mounted** — screws directly on valve motor with heavy duty stainless steel ¼" fitting . . . eliminates "lag" commonly caused by transmission lines.
- **Fixed Settings** — exclusive live-balance design of the M/59 Controller permits fixed proportional and reset values for all flow conditions . . . for all valve motor sizes. (Reset can be field-adjusted for special purposes.)
- **Response** — amazingly fast recovery with precise control regardless of load conditions and process upsets. No control point drift. Unaffected by vibration or wide changes in ambient temperature.
- **Seal Valve** — optional feature which permits isolation of controller and remote manual control of process. Integrally mounted to the bottom of the controller.
- **Maintenance-free** — nothing to align, nothing to wear out. Flexure strip fulcrum eliminates friction and wear of conventional type pivots. Tightly gasketed, completely weatherproof.

**Unique Live-Balance Design**

Photo of the M/59 with cover removed to show the exclusive, simplified live-balance mechanism. Balance Beam, which moves only a few thousandths of an inch to control the valve motor pressure, is flexure-pivoted and positioned between the four bellows. Any pressure unbalance between the set point and measurement bellows will change position of the Balance Beam. The proportional-reset bellows opposes such unbalance and prevents control point drift, while the fourth bellows provides the desirable amount of derivative action.

FOXBORO
REG. U. S. PAT. OFF.
INSTRUMENTS
INDICATING
RECORDING
CONTROLLING

**SEE IT IN OPERATION AT I. P. E. BOOTH 80N (NORTH ENTRANCE)**

# In electrical installations *where QUALITY counts* use CONDULETS*

Quality does count in practically every electrical conduit installation that you make. When you use CONDULETS you know that you are putting in electrical equipment of the highest quality, because CONDULETS have been doubly tested . . . in the factory and in the field.

Crouse-Hinds quality control assures a long-lasting product and field records prove it by the test that only time can give. Thousands of CONDULET installations are still in tip-top condition after twenty, thirty, or even more than forty years of dependable service.

The illustration at the right shows four of Crouse-Hinds' basic quality features that are common to all CONDULETS. The fifth, Wedge Nut Fasteners, is an exclusive Crouse-Hinds feature that has made Obround CONDULETS preferred by electricians everywhere.

Type EVA Explosion-Proof Lighting Fixture

Type ARE Arktite Receptacle Equipment

Type FS Condulet With Pilot Lamp Receptacle, Switch and Plug Receptacle

Type GUAC Explosion-Proof Junction Condulet

1. **Taper tapping.** Condulet threads are taper tapped to match tapered conduit threading. Makes a rigid joint that will not loosen. This assures permanent ground continuity . . . important for safety.
2. **Integral bushing.** A smooth rounded surface protects wire insulation.
3. **Material.** Feraloy . . . a special alloy that is strong and tough, resists corrosion, and gives sharp full threads.
4. **Finish.** A triple treatment provides long-lasting protection . . . exceeds Federal and U. L. specifications.
5. **Wedge Nut cover fastener.** Clear cover opening . . . no projections. No loose parts . . . Wedge Nuts and screws self-retained. No screw holes to align.

More than 15000 items are listed in the Condulet Catalog including a complete explosion-proof and dust-tight line for use in hazardous locations.

On your next job, use CONDULETS . . . they're made right to last longer.

**CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.*

Type VC Vaportight Industrial Lighting Fixture

Type FLB Explosion-Proof Circuit Breaker Condulet

Type EPC Explosion-Proof Motor Starter and Circuit Breaker Condulet

A Nationwide Distribution Through Electrical Wholesalers

**CROUSE-HINDS COMPANY**
Syracuse 1, N. Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee — Minneapolis — New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle — St. Louis — Tulsa — Washington
RESIDENT REPRESENTATIVES: Albany — Atlanta — Baltimore — Charlotte — Corpus Christi — Richmond, Va. — Shreveport
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

**CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS**

"WHY DO YOU ALWAYS ORDER SOLVAY ALKALIES, JOE?"

# "I'll tell you why I count on SOLVAY *FIRST* for Alkalies...

SOLVAY

SOLVAY CHEMICALS FOR THE PETROLEUM INDUSTRY

Soda Ash
Caustic Soda
Caustic Potash
Calcium Chloride
Sodium Nitrite

• • • **As you know,** Solvay is a pretty big company. But I've always found that Solvay service has that personal touch . . . that little something that makes me feel like a valued customer, whether I buy big or small. In a nutshell, Solvay combines the service and facilities of a big company, with the friendly feeling of a small company that really has my interest at heart.

For instance—I always get courteous service from the Solvay sales staff. They always seem to be willing, even anxious, to help me. And as far as delivery is concerned, I get the same prompt delivery as the big fellows.

But probably the most important thing I get is Solvay's "Industry-Wise" Technical Service . . . a specialized, exclusive service that includes technicians who have an intimate knowledge of *my* industry. They give me advice and suggestions—and it costs me nothing.

These are the things that make me count on *Solvay first* for my alkalies."

**SOLVAY PROCESS DIVISION**

Allied Chemical & Dye Corporation
**61 Broadway, New York 6, N. Y.**

*BRANCH SALES OFFICES*

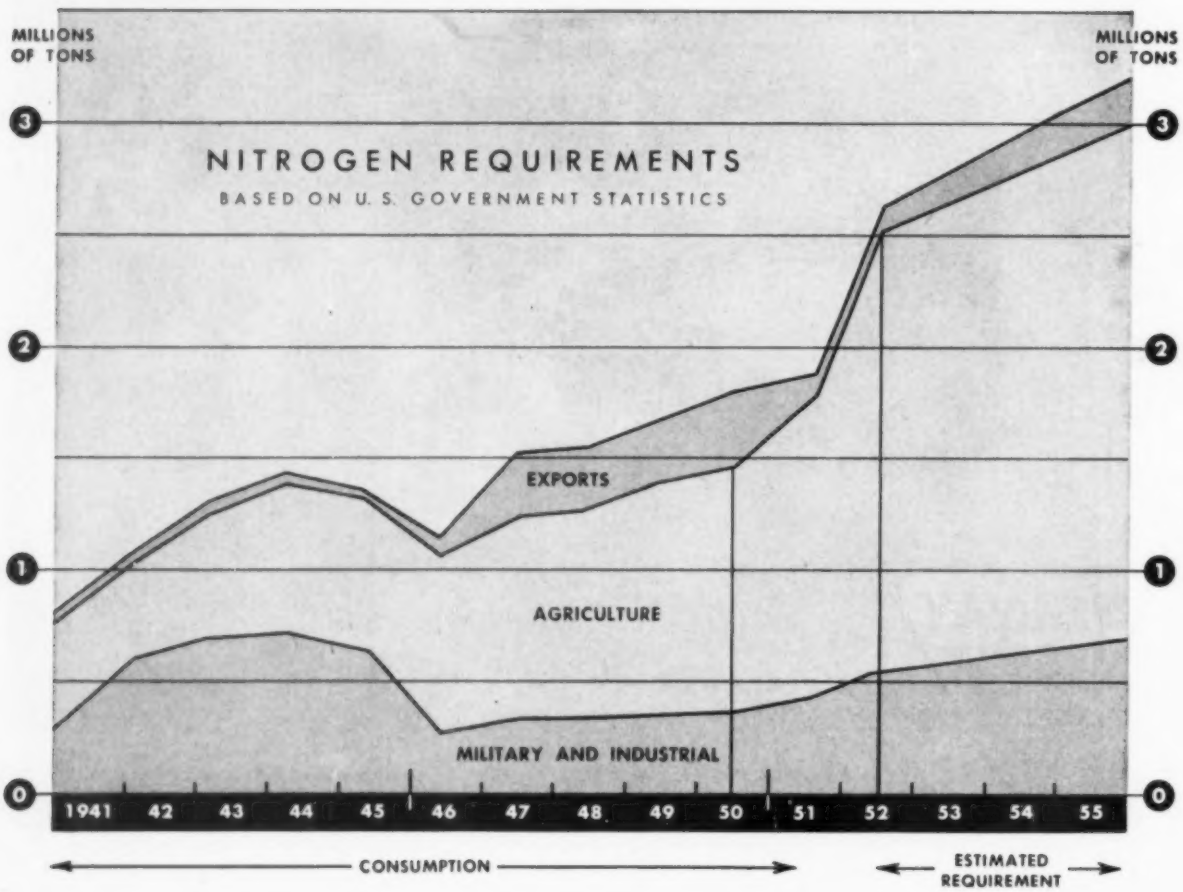
Boston • Charlotte • Chicago • Cincinnati • Cleveland • Detroit
Houston • New Orleans • New York • Philadelphia • Pittsburgh
St. Louis • Syracuse

**ARE YOU KEEPING STEP WITH THE *rapidly expanding* FERTILIZER MARKET?**

If you are contemplating entering the fertilizer business or expanding your present facilities, you will do well to have Chemico handle your plant design and construction problems.

Regardless of whether your product will be urea, some other nitrogenous fertilizer or phosphate, we will handle your project on a one-contract, one-responsibility, performance-guaranteed basis.

The experience we have gained from more than 900 heavy chemical installations throughout the world is assurance of successful completion and efficient operation of your plant.




**CHEMICAL CONSTRUCTION CORPORATION**

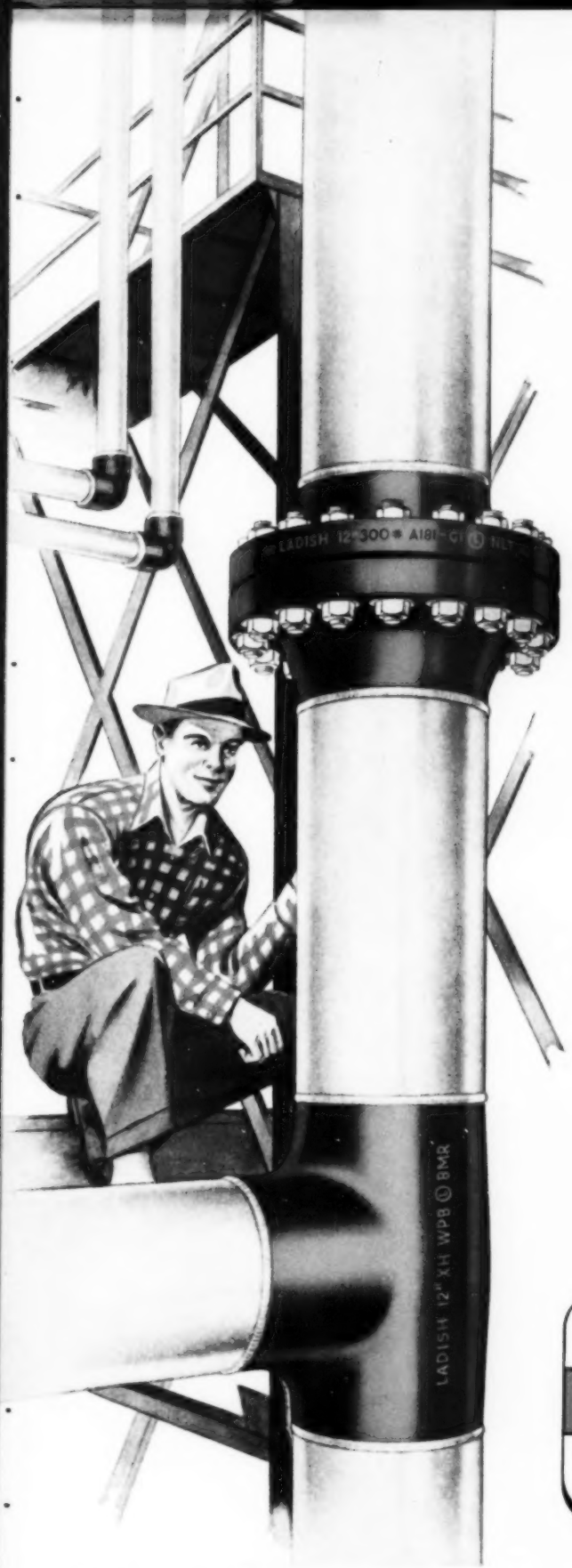
A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

CABLES: CHEMICONST, NEW YORK

TECHNICAL REPRESENTATIVES: CYANAMID PRODUCTS LTD., LONDON • CHEMICAL CONSTRUCTION (INTER-AMERICAN) LTD., TORONTO • SOUTH AFRICAN CYANAMID (PTY) LTD., JOHANNESBURG

*Chemico plants are profitable investments*




# LADISH

*Controlled Quality*

## PIPE FITTINGS

### maximum service assured by metallurgical soundness

Sound metallurgy . . . the result of unsurpassed facilities and advanced laboratory controls . . . provides the maximum of dependability in Ladish Controlled Quality fittings. Every phase of metal quality . . . composition, structure and physical properties . . . is continuously safeguarded—and certified proof of metallurgical integrity is available to users of Ladish fittings.

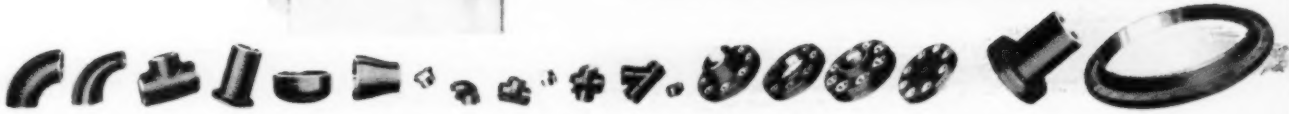
TO MARK PROGRESS

**AT THE INTERNATIONAL PETROLEUM EXPOSITION**
**BOOTHS 7, 8 and 9, KANSAS BUILDING**

**LADISH CO.**

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

*District Offices* New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • San Francisco • Havana • Mexico City • Brantford, Ont.



# *It takes a Giant to catch a Giant*

IT's always exciting to watch a little guy challenge a big guy—and win. That's why Jack the Giant Killer has topped the list of popular children's stories for centuries. And that's why we think the oil business is the most thrilling business in the world. It's a contest between Men and a modern Colossus.

Not just any men. It takes men of tremendous initiative and daring—giants in their own right—to stalk the reluctant giant, Petroleum, drag him from his lair, civilize him, and put him to work.

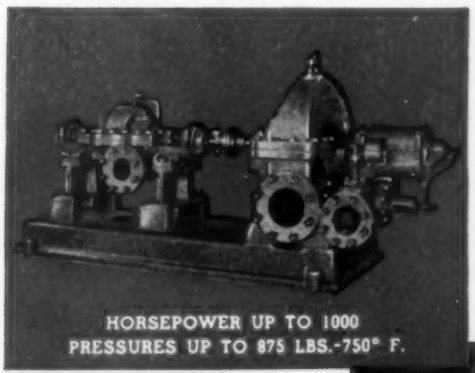
Cities Service is well equipped with such men. Geologists who, at great personal hardship, track down the giant in his native haunts. Production men who risk all to bring him out alive. Refinery operations men, who domesticate and train him. Research men, who think of new ways to utilize his strength.

The mammoth muscles of petroleum have taken over some of mankind's hardest, most back-breaking jobs. We think a lot of credit is due the great-hearted Cities Service "Jacks" who've devoted their lives to finding, catching and domesticating this mightiest of modern "Giants."

CITIES SERVICE

*Quality Petroleum Products*

# Designed with the operator in mind!

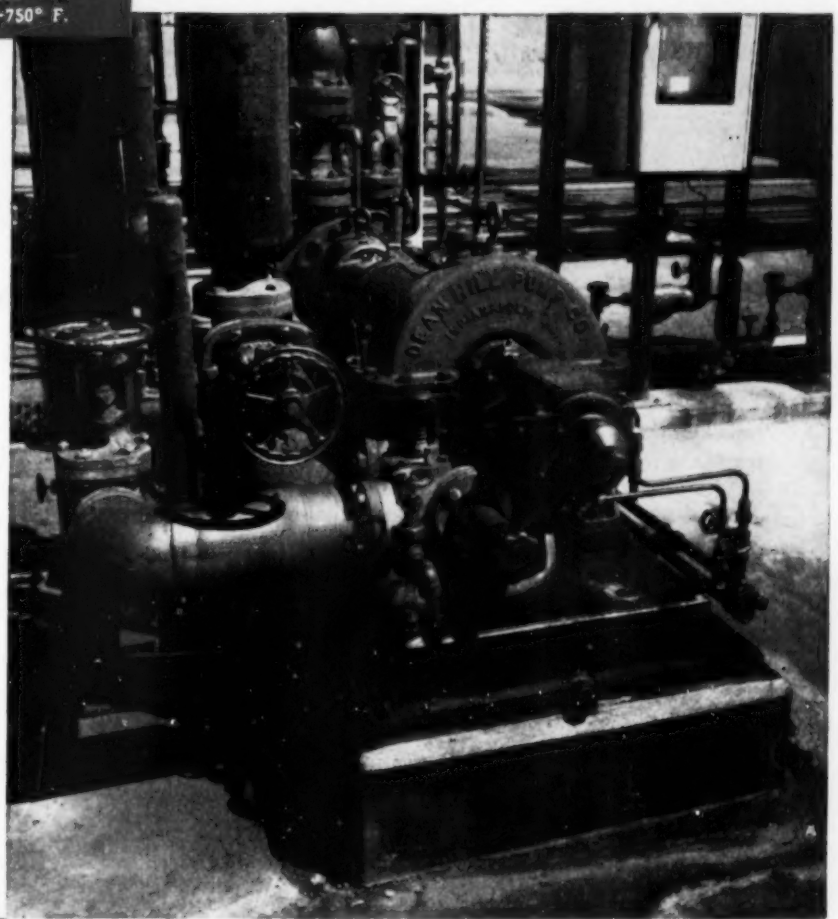


HORSEPOWER UP TO 1000
PRESSURES UP TO 875 LBS.-750° F.

No streamline housings.
No needless cover-ups.
Nothing fancy or frilly about these power-making huskies. Dean Hill Steam Turbines are designed and built for nothing but long service and easy, economical operation. Their heavy, rugged construction is simple and uncluttered for quick, easy maintenance. All pressure parts are outside and visible to operator.

## DEAN HILL STEAM TURBINES

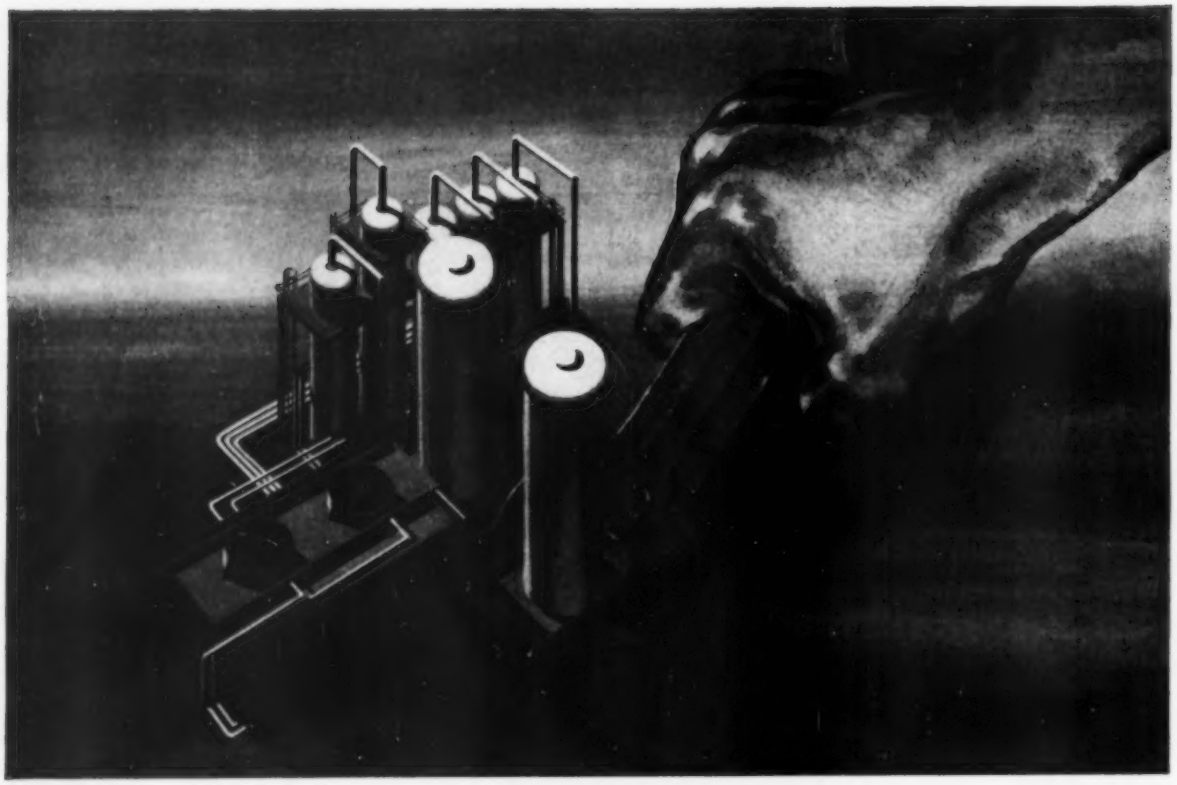
.....are single stage, double impact type for low steam consumption. Specifically designed for operation at medium steam pressures and temperatures, DH Turbines have all the advantages available under these conditions, including excellent water rates. Write us for further information and complete specifications.



One of eighty-four Dean Hill Steam Turbines recently installed in a large, eastern Refinery

DEAN HILL PUMP COMPANY
*Pump and Turbine Engineers Since 1895*
INDIANAPOLIS 7, INDIANA

SALES OFFICES IN:
Chicago • Mexico City • Philadelphia • Salt Lake City • New York • Dallas • New Orleans • San Francisco • Denver • Los Angeles • Pittsburgh • Houston • St. Paul • Cleveland



# How To Bolt Down Profits In New Production Planning

Has a tough operating problem threatened your output schedules? Here's how one producer licked his problem before it started.

For a new process this refinery required economical heating, under vacuum, of highly corrosive crude that was to be pumped into a fractionator for further processing.

SOLUTION: Crude oil feed tanks of stainless-clad steel, vertical type, externally braced. Heat is provided by an internal steam coil of solid stainless steel. Vacuum operation is withstood successfully by clad steel tank design. Flued openings and manholes provide for easy inspection and maintenance. Inner stainless surfaces resist corrosion; carbon steel backing and steel stiffening rings insure rigidity and strength with maximum economy. Result: economical heating of crude oil to proper temperature. Corrosion problem eliminated by equipment with low first cost and long service life. Maintenance costs reduced to a minimum.

This unit increased this company's output and profits. It was ideal for the job. How was this advance achieved? Through close coordination between engineering staffs of progressive Equipment Builders, process engineers, designers and materials suppliers.

Such bonus attention is a practice with progressive Equipment Builders. They turn to Lukens regularly for its knowledge of materials as well as its wide range of low-cost clad steels.

Would you like such specialists to study your problem? We will send you their names. Write today explaining your need. Manager, Marketing Service, 404 Lukens Building, Coatesville, Pa.

LUKENS

*World's Leading Producer of*

SPECIALTY STEEL PLATE · PLATE SHAPES · HEADS · CLAD STEELS

LUKENS STEEL COMPANY, COATESVILLE, PA.

# The New GRINNELL MODEL R CONSTANT SUPPORT HANGER

**FEATURES OF GRINNELL MODEL R CONSTANT SUPPORT HANGER:**

- 3 frame sizes provide maximum travel of 4 inches, 8 inches and 12 inches respectively to accommodate all loads from 48 to 9,304 pounds
- Non-resonant
- Anti-friction needle bearings keep friction to a minimum
- Individually calibrated before shipment to support exact load specified
- Requires less head room
- Can be bolted directly to the building structure or suspended by either single or double rods

**SEND FOR DETAILED CATALOG ON NEW GRINNELL MODEL R CONSTANT SUPPORT HANGER**

**Mathematically perfect constant support for all positions of travel of high temperature process and steam piping**

With the new Grinnell Model R Constant Support, the pipe, its covering and contents, are supplied mathematically perfect support in all positions of travel. In addition, constant support is maintained throughout the full range of field adjustability.

The design of the new Model R provides favorably small ratios between spring force and the supported load, ranging from 1.15 to 1 minimum and 4 to 1 maximum, thereby minimizing bearing stress and prolonging the life of the hanger. This permits hangers which are smaller in size for the loads carried.

If conditions require a change of supporting force, a load scale is provided so that accurate field adjustments of at least plus or minus 10% may be made by turning a *single* load adjusting bolt. Wherever the adjustment is set, the Model R gives a load deflection curve that is a straight horizontal line.

# GRINNELL

**AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPLIERS**

**Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors**

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

*Ever ask your* **TREASURER . . .**

## WHAT *HE* THINKS OF YOUR TANKS?

### (A POSEY IRON Bid Might Interest Him and YOU)

Most treasurers are apt to put cost first. And cost is certainly *not* the only factor to consider when buying steel plate construction.

But —

It's good engineering as well as good financial policy to refuse to pay a penny more for tanks . . . or pressure vessels . . . or stacks . . . than is necessary fully to meet *the standard desired.*

The Posey Iron Works offers you 42 years of money-saving experience over the full range of steel plate fabrication . . . *practical* engineering and design service that concentrates on structural integrity and safety rather than on cost-padding "frills".

That's why we say a Posey Iron bid might interest your treasurer as well as you.

*Edges of Plates Properly Prepared for Welding . . .*
*Electrodes Carefully Selected*

Perhaps more than any other production step, welding influences tank costs and structural soundness. Every electric welder in Posey's shops is fully qualified. No plate is welded without proper preparation of edges . . . electrodes are chosen after careful consideration of requirements.

Posey meets all standard codes including ASME; API-ASME; API. Consultation does not obligate you.

*Posey Iron Works self-supporting stacks installed at the Niagara Falls Plant of the International Graphite & Electrode Division of Speer Carbon Co. Height: 50 ft. Diameter: 3 ft.*

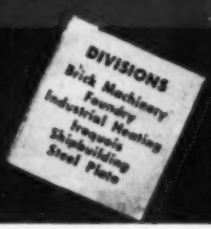
**POSEY IRON WORKS, INC.**

*Steel Plate Division*

LANCASTER, PA.

New York Office: Graybar Building

ESTABLISHED SINCE 1910



NATIONAL FOAM SYSTEM
CONTINUOUS FOAM PRODUCTION

# FOAM FACTS

Published quarterly in the interests of fire protection everywhere.

**NATIONAL FOAM SYSTEM, INC.**

WEST CHESTER, PENNA.

## Portable Foam House Cuts Maintenance Costs, Allows Plant Expansion

A large Southern refinery was recently faced with the need of eliminating the excessive cost of maintaining its main line chemical foam piping system. Also, a more flexible system was wanted, to allow for future expansion.

### Portable System Devised

To solve this problem, engineers of National Foam System designed and installed a completely portable "Foam House on Wheels," consisting of two trucks and a trailer. Each truck was equipped with an Aer-O-Foam Liquid Proportioning Pump, a 900-gallon tank for Aer-O-Foam Liquid 3% Regular, nozzles and hose. One truck was equipped with a water pump, the other designed so that a water pump could be added later if desired. The trailer housed a gasoline-driven pump and hose.

### Costly Piping Eliminated

Foam house and main line piping were abandoned, and only the lateral piping to foam chambers was retained. All existing chemical foam chambers were converted with the new National MCV foam makers for use with mechanical Aer-O-Foam.

### Complete Flexibility

When fire occurs, a truck or trailer is spotted at a point near a water hydrant, the hose is connected and, when water is flowing through the truck, the Aer-O-Foam Liquid Proportioner is adjusted to inject foam liquid at the proper rate. Two flow meters provide a continuous check on the accuracy of the water and Liquid input. When tanks are not equipped with chambers, foam towers are similarly used.

The result is better, more flexible protection, elimination of the costly piping system and foam house, and adaptability to the expansion plans of the refinery.

## COMPLETE FOAM FIRE PROTECTION... NO WATER OR POWER SUPPLY NEEDED WITH NEW NATIONAL PRESSURE-PACK

For complete foam fire protection where neither water nor power is available, the new National Pressure-Pack is the ideal answer. Here is a completely self-contained, pressurized, mechanical foam unit, supplied in four standard sizes ranging from 33- to 200-gallon solution capacity. The largest unit can produce 2,000 gallons of fire-smothering Aer-O-Foam in less than three minutes.

The Pressure-Pack is designed for use with overhead spray deflectors, dip tank or drainboard deflectors, floor nozzles or portable nozzles. Installations may be either portable or fixed. Operating pressure is supplied by a nitrogen or air cylinder.

A control for local manual operation is provided. Other available controls include remote manual operation, completely automatic operation, or any combination of these controls. The unit is easy to install and maintain, can be tested at any time without using Aer-O-Foam Liquid, and can be recharged in a matter of minutes after use.

For all isolated hazards, or wherever water and power are not available, the Pressure-Pack supplies the same dependable Aer-O-Foam that is so widely used by the largest refineries and bulk plants. A complete descriptive folder is yours for the asking.

## 150 Years of Skill

Although National Foam System, Inc., marks the Silver Anniversary of its incorporation this year, its experience goes back almost 150 years, through the days when its predecessor, James Boyd & Bro., was later one of the largest manufacturers of motorized fire-fighting apparatus.

In the late 1920s, National Foam developed the first dual-line dry powder chemical foam system used in this country. In World War II, National helped to save innumerable lives and ships through its development of Aer-O-Foam, the mechanical foam known as "Navy Bean Soup." Again, National helped design equipment for loading jelly gasoline fire bombs.

Today National Foam System still serves the Armed Forces while it expands to meet the growing needs of industry. New products, improved designs, greater variety are combined in National Foam's largest and most versatile line of foam and foam equipment to be found anywhere.

**Send for Your Free FOAM FACTS Subscription**

**FOAM FACTS, a quarterly magazine packed with interesting information on foam fire-fighting, will be mailed to you entirely free upon request. Just send your name and address to National Foam System, Inc., West Chester, Pa. There's no obligation, of course.**

Over two million workers in America are injured annually in on-the-job accidents. Of those injured, ninety thousand suffer permanent injuries or impairments and many are totally disabled for life. Add to this the sixteen thousand killed annually in on-the-job accidents and you get an idea of the terrible toll we pay for our carelessness.

**MOST ACCIDENTS CAN BE PREVENTED**

Safety Engineers tell us and many Safety minded business and industrial firms are proving that most on-the-job accidents can be prevented. Do YOU have a Safety Program? If you do, it's your responsibility to give it your full support. If you do not, it's your responsibility to get one started as quickly as possible.

# Accident PREVENTION Pays

*Largest Writer of* WORKMEN'S COMPENSATION INSURANCE *in Texas*

HOMER R. MITCHELL, *Chairman of the Board* A. F. ALLEN, *President*

Service Offices: ABILENE • AMARILLO • AUSTIN • BEAUMONT • CORPUS CHRISTI • DALLAS • EL PASO
FORT WORTH • FREEPORT • GALVESTON • HARLINGEN • HOUSTON • LUBBOCK • LUFKIN • MIDLAND
ODESSA • PORT ARTHUR • SAN ANGELO • SAN ANTONIO • SHERMAN • TYLER • WACO • WICHITA FALLS

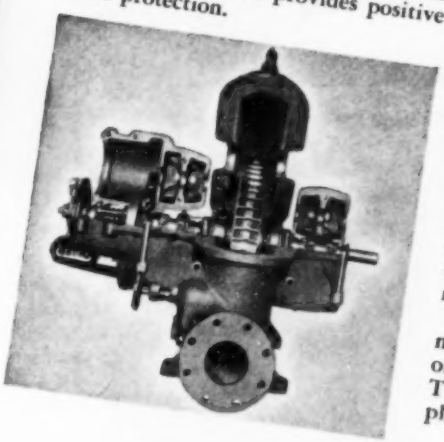
**TEXAS EMPLOYERS INSURANCE ASSOCIATION**
HOME OFFICE - DALLAS, TEXAS

# TERRY

## PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

**THE TERRY STEAM TURBINE CO.**
TERRY SQUARE, HARTFORD 1, CONN.

TT-1195

*Memo*

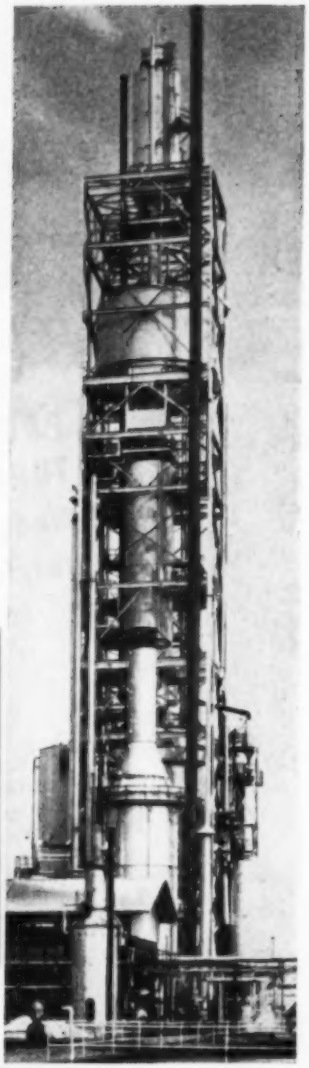
Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

## Visit the
## CHICAGO BRIDGE & IRON COMPANY
## Exhibit at the
## INTERNATIONAL PETROLEUM EXPOSITION

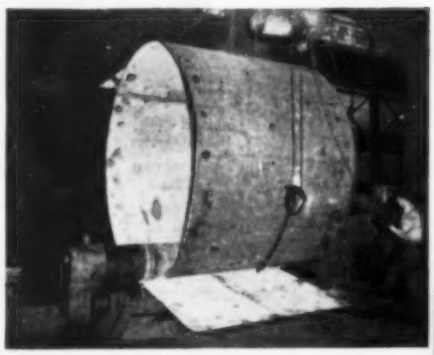
Our exhibit is in the Texas Building, Booths No. 85-86-125-126. We will be glad to see you . . . and to tell you about Chicago Bridge & Iron Company welded steel tanks and other steel plate structures. Perhaps we can recommend a Horton structure that will help you solve a problem or save you money.

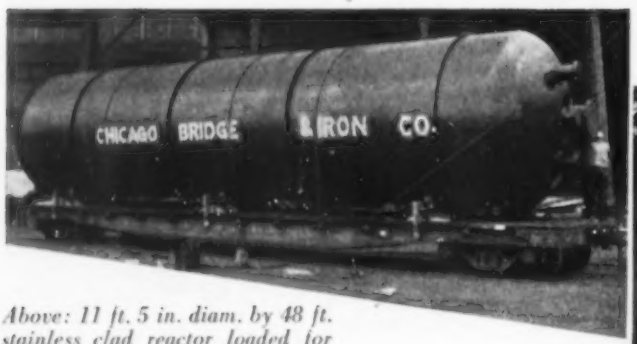
While visiting our booth, be sure to ask about Chicago Bridge & Iron Company's FIELD WELDING SUPERVISORY SERVICE. This CB&I service, which is provided at no extra cost to you, assures you of the best welded steel plate structures your money can buy!

Chicago Bridge & Iron Company builds Hortonspheres, Hortonspheroids, Hemispheroids, Horton Floating Roofs, Horton Lifter Roofs, Vaporspheres, Vaportanks, Hortondome Roofs, refinery towers and vessels and other steel plate structures for the petroleum industry. Be sure to see us at the IPE . . . or write our nearest office for further information.



*Right: Workman rolling stainless clad shell plates for a reactor. After this operation is finished, the ends of the plates will be welded together.*






*Above: 11 ft. 5 in. diam. by 48 ft. stainless clad reactor loaded for shipment to the Derby Oil Company's Wichita, Kansas, refinery.*

*Above: New catalyst cracking unit at the Derby Oil Company refinery. Left: Workmen attaching the catalyst distributor cone near the top of the reactor.*

# CHICAGO BRIDGE & IRON COMPANY

**Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA**

| | | | | | |
|---|---|---|---|---|---|
| Atlanta 3 | 2146 Healey Building | Detroit 26 | 1520 Lafayette Building | New York 6 | 3302—165 Broadway Building |
| Birmingham 1 | 1548 North Fiftieth Street | Havana | 402 Abreu Building | Philadelphia 3 | 1608—1700 Walnut Street Building |
| Boston 10 | 1030—201 Devonshire Street | Houston 2 | 2126 C & I Life Building | San Francisco 4 | 1551—200 Bush Street |
| Chicago 4 | 2463 McCormick Building | Los Angeles 17 | 1534 General Petroleum Building | Seattle 1 | 1331 Henry Building |
| Cleveland 15 | 2234 Midland Building | | | Tulsa 3 | 1626 Hunt Building |

*REPRESENTATIVES AND LICENSEES*

Ateliers et Chantiers de la Seine Maritime, Paris, France
Compagnia Tecnia Industrie Petroli, Rome, Italy
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Sociedade Chibridge de Construcoes Ltda, Av. General Justo, 275, Grupo, 306, Rio de Janeiro, Brazil
Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Whessoe, Limited, Darlington, England
Comprimo N. V., 21 Amstel, Amsterdam (C) Netherlands

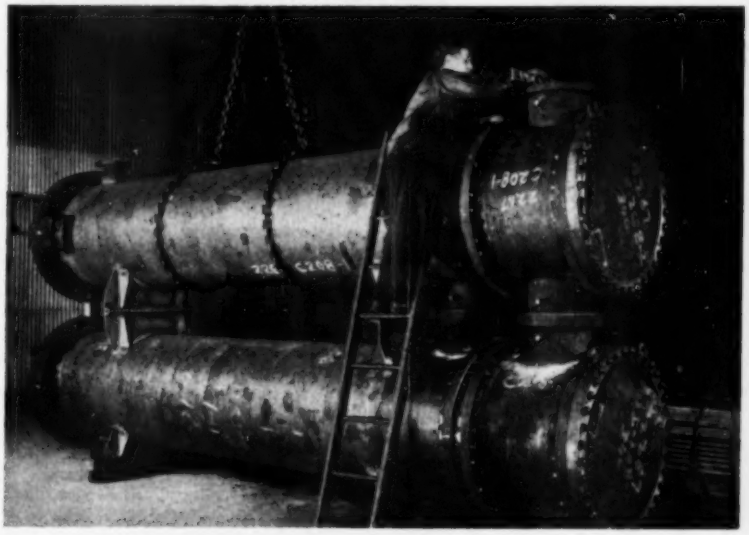
# PROCESS EQUIPMENT NEWS

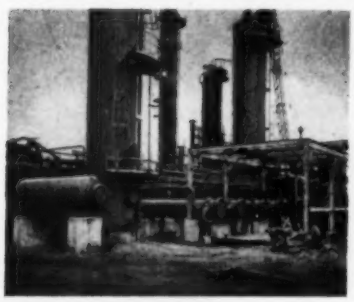
PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY MAY 1953

## Special Units Developed for Sasol Project

In connection with Kellogg's work on the gasoline-from-coal synthesis plant for SASOL in South Africa, a special heat exchanger has been designed for preheating gases from the coal-gasification unit against reaction gas from the reformer.

Five of these units, each capable of operating under temperatures 1775°F and pressures of 365 psi are now being fabricated. Kellogg's extensive experience with the fabrication of hi-pressure — hi-temperature equipment — was a major reason for the decision to fabricate these critical exchangers for this process in the Kellogg plants.





### More than 100 Exchangers for Eastern Refinery

Progress photo of sulfur removal unit shows just three of the many types of exchangers included in this one order. Balance of more than 100 units include complete heat exchange requirements for atmospheric distillation, Fluid cat cracking and vapor recovery facilities.

## Multi-Section Naphtha Cooler Furnished for Eastern Refinery

One of several units now being fabricated for a major independent refiner, this debutanizer bottoms cooler is shown here as it is being stacked in the Kellogg plant preparatory to final machining of nozzles. This is done so that when the unit is set up in the field, no further adjustments are necessary.

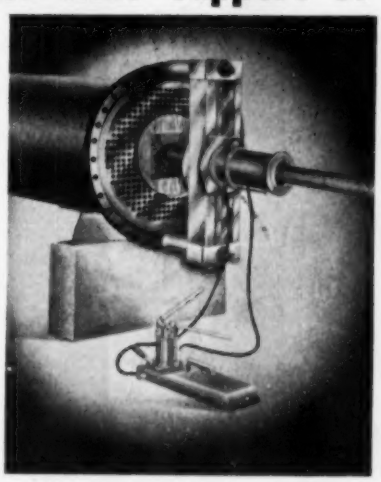
The unit is constructed using naval brass tube sheets, Admiralty metal tubes, ¾ inch, 16 BWG, 16 feet long, arranged on a 1" square pitch. Baffles, floating head cover, channel, shell and channel cover are of carbon steel. In service, the equipment will handle 278,947 lbs. per hour of naphtha on the shell side, reducing its temperature from 290°F to 100°F. On the tube side, 1933 GPM of water is used, the water being raised from 90°F to 120°F.

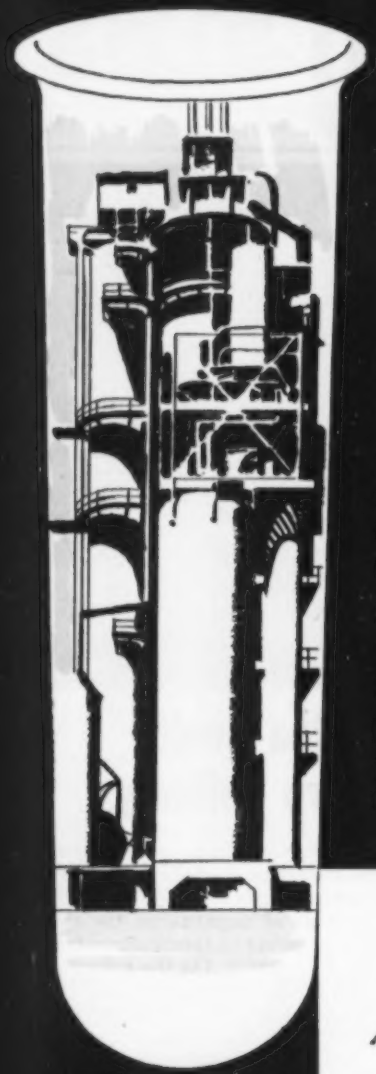
Kellogg has constructed this unit in accordance with its general practice, namely: TEMA standards and, in addition, the 1950 ASME Unfired Pressure Vessel Code.

FABRICATED PRODUCTS DIVISION
THE
M. W. KELLOGG
COMPANY
PULLMAN

## Unique Hydro-Ejector Wins Support of Maintenance Men

Sales of this new hydraulic device for removing tube bundles from exchangers are growing steadily both here and abroad, as maintenance men in refineries and other chemical processing plants continue to discover the Hydro-Ejector's many advantages. It is readily portable by *one* man, it pulls bundles faster, is safer for crews, eliminates costly rigging, and in new installations saves material amounts of structural steelwork. Using the device, two men can handle even the largest bundles . . . experience proving that it takes less than 25 minutes to push any sized bundle out eight feet. The Hydro-Ejector can exert a force of 12,000 pounds, sufficient to overcome dirt formations that cause many bundles to stick.





AEROCAT® MS Synthetic Fluid Cracking Catalysts

# CYANAMID offers integrated service to meet your chemical requirements

## ...from well to finished product

Staffed by specialists, Cyanamid's integrated Petroleum Chemicals Department serves every phase of the petroleum industry.

The extent of this service is illustrated by the department's ability, based on continuing research and large manufacturing facilities, to meet the chemical requirements of the industry's many branches—from drilling mud conditioners to gelling agents, specialty catalysts to lube oil additives.

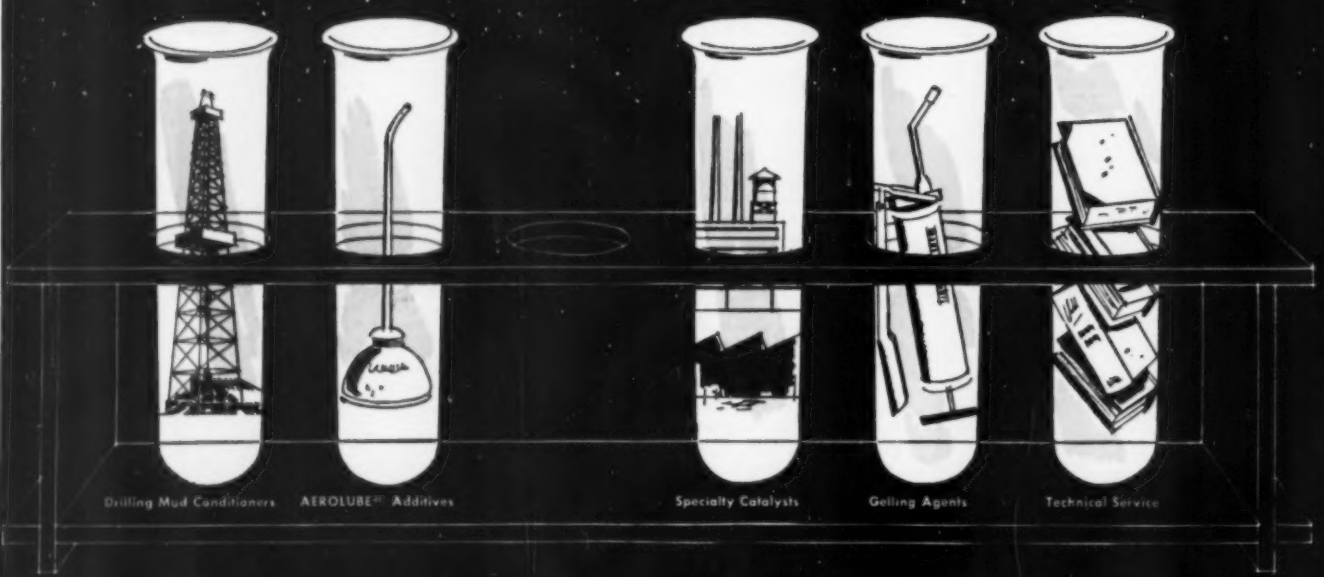
Cyanamid Petroleum Chemicals—results of an extensive development program—are now helping to speed the flow from well to consumer of every type of petroleum product.

For example: among the five out of six fluid cat cracking refiners who use synthetic catalyst, nine out of ten use Cyanamid's AEROCAT® MS Catalyst.


AMERICAN Cyanamid COMPANY

**PETROLEUM CHEMICALS DEPARTMENT, DIV. PR-5**
**30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.**

In Canada: North American Cyanamid Limited, Toronto and Montreal

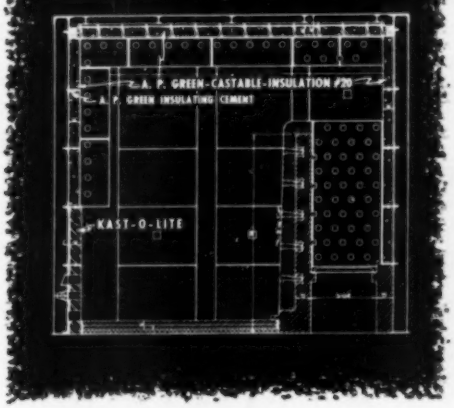
Drilling Mud Conditioners | AEROLUBE® Additives | Specialty Catalysts | Gelling Agents | Technical Service

A. P. Green
REFRACTORY PRODUCTS

# 6 REASONS WHY

# A. P. GREEN

## LIGHTWEIGHT CASTABLE REFRACTORIES REDUCE COSTS AND INCREASE EFFICIENCY IN OIL HEATERS AND OIL STILLS




Cross section drawing of an oil heater in Gary, Indiana. This heater is one example of the numerous uses for A. P. Green lightweight castable refractories in the petroleum industry.

For use in panel casing construction in new or old oil heaters and stills, A. P. Green castable refractories offer you these 6 advantages:

1. Lightweight insulating castables reduce heat loss... improve temperature control and heat distribution.
2. Securely anchored lining — gives long, trouble-free service.
3. Increases the performance and efficiency of the furnace. With fewer joints, air infiltration is reduced to a minimum.
4. Simplified construction — reduces erection time.
5. Lowers maintenance costs. Any tube section may be repaired by removing a series of the panels without disturbing the balance of the furnace arrangement.
6. Lower foundation costs due to the use of lightweight materials.

The A. P. Green Engineering Department will assist you with further information on the application of these materials to new units or the conversion of existing furnaces. Call your local A. P. Green distributor — he's listed in the yellow pages of your telephone directory — or write...

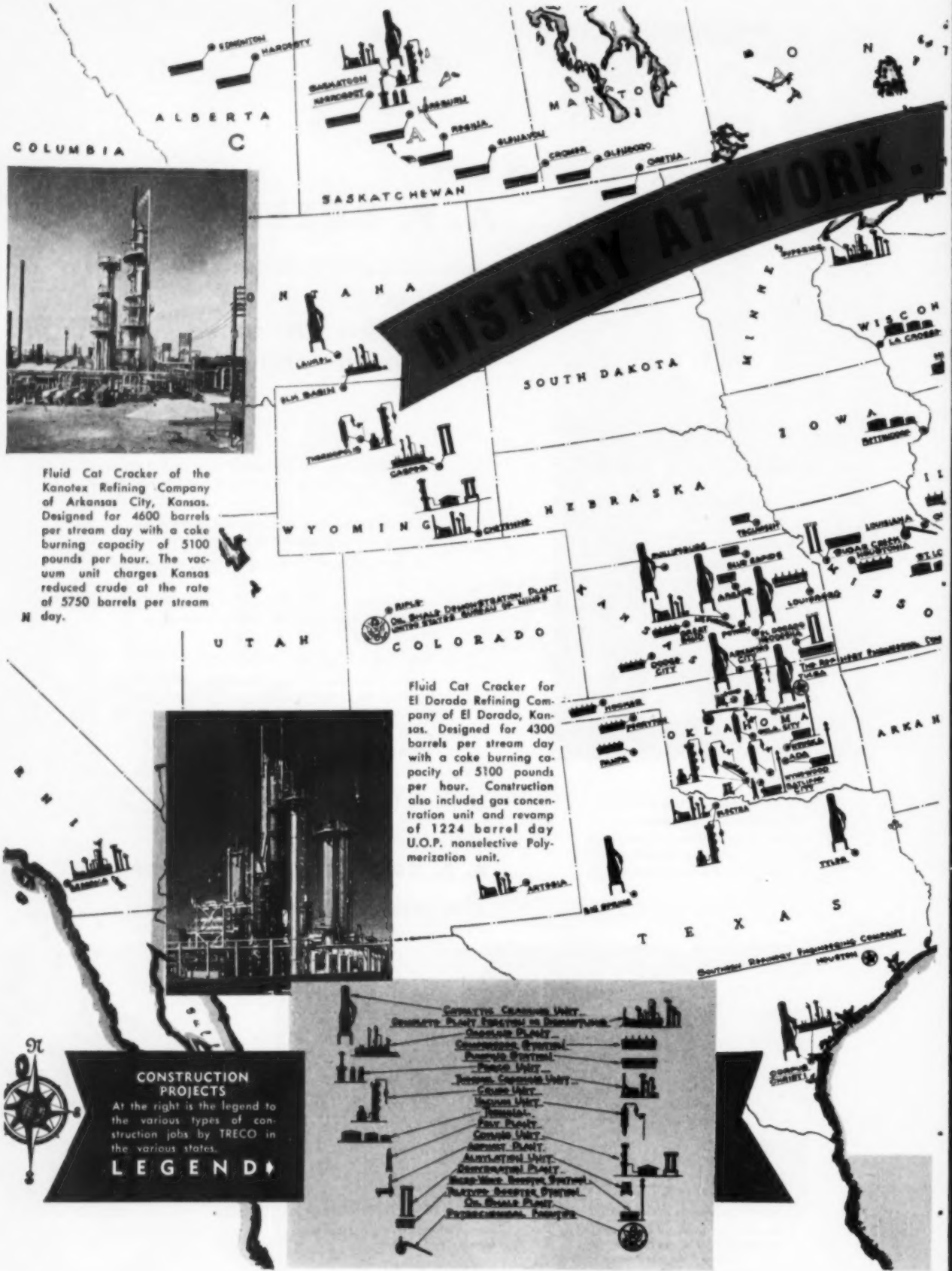
**A. P. GREEN FIRE BRICK COMPANY**
Mexico, Missouri, U. S. A.

*In Canada*
**A. P. GREEN FIRE BRICK COMPANY, LTD.** Toronto 15, Ontario
DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

The castable is poured and anchored to the steel panels on the job site. The simple formwork has been removed and the panels are awaiting erection.

Interior view of side wall showing panels being erected.

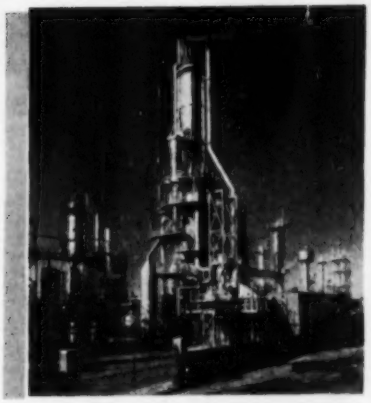
View of outside panel casing.




Fluid Cat Cracker of the Kanotex Refining Company of Arkansas City, Kansas. Designed for 4600 barrels per stream day with a coke burning capacity of 5100 pounds per hour. The vacuum unit charges Kansas reduced crude at the rate of 5750 barrels per stream day.

Fluid Cat Cracker for El Dorado Refining Company of El Dorado, Kansas. Designed for 4300 barrels per stream day with a coke burning capacity of 5100 pounds per hour. Construction also included gas concentration unit and revamp of 1224 barrel day U.O.P. nonselective Polymerization unit.

# . . . IN REFINING . . . . . .



Fluid Cat Cracker for Farmers Union Central Exchange, Laurel, Montana, of 5,000 barrels per day at 70% conversion. 2 stage gas concentration units; solid phosphoric acid Polymerization unit, Tank car and truck loading facilities for LPG.

Last year was the greatest construction year in the refining industry. This year promises to be even greater. Thinking operators know they can't win in quantity or quality production with out-moded plants. That's why TRECO receives contracts for a number of new plants each year, putting the owner in a more competitive position.

REFINERY ENGINEERING Company has proven to the industry that it builds a quality refinery, producing top-quality products; "on stream" with new records for speed of construction. From an economic study of your needs to operating costs, yields and profits; through design and construction, TRECO has the knowledge, experience and manpower to complete the most complicated construction and installation in the shortest possible time.

Call on TRECO for a conference while your project is still in the planning stage. Executives of our organization are as near as your telephone.

TRECO has been licensed to design, engineer and construct Catalytic Reforming Units.

*Write for a free copy of our new brochure showing many of the refineries we have constructed. A copy will be mailed you promptly upon request on your company letterhead.*

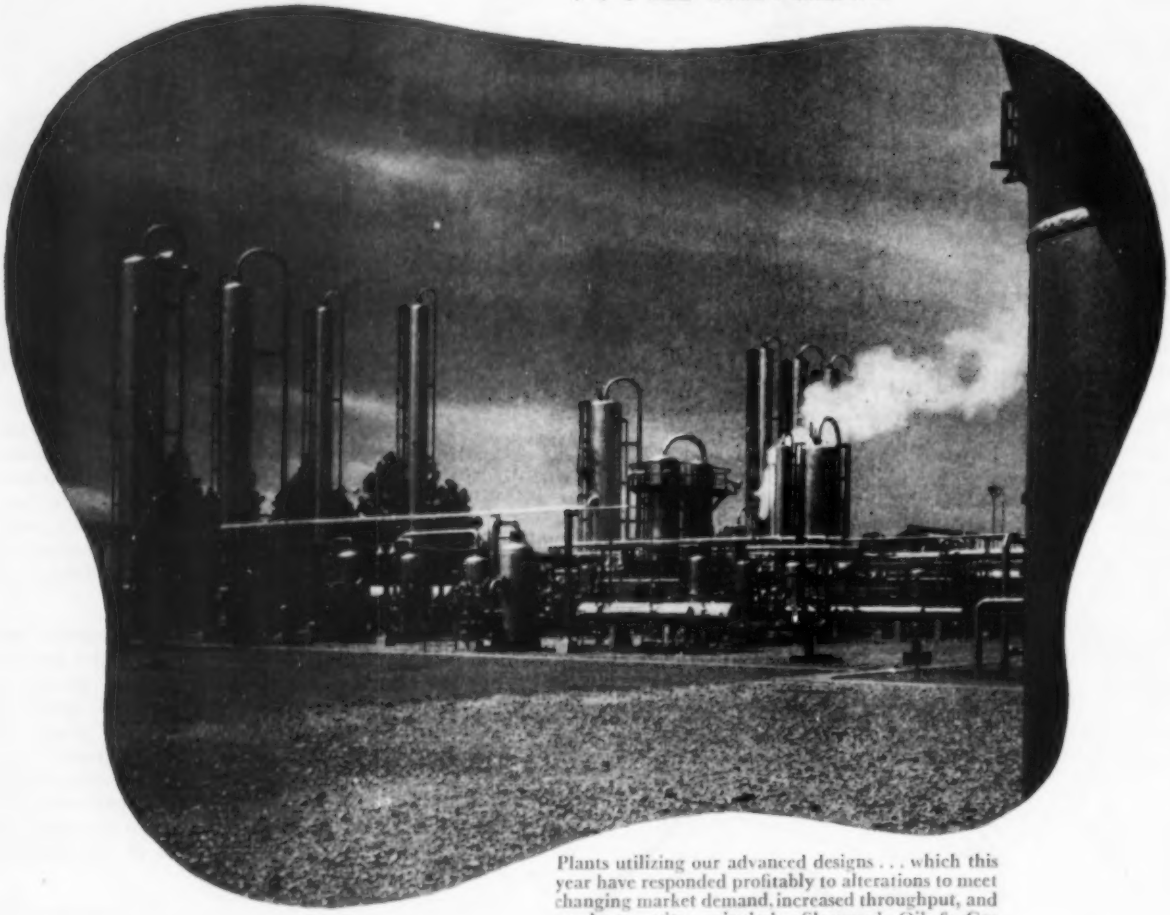
TRECO

REFINERY ENGINEERING Company

HOUSTON, TEXAS TULSA, OKLAHOMA TORONTO, CANADA

# REALISTIC PLANT EVALUATION

## . . . in advance



Plants utilizing our advanced designs . . . which this year have responded profitably to alterations to meet changing market demand, increased throughput, and product purity . . . include: Shamrock Oil & Gas Corp., Natural Gasoline Corp., Panoma Corp., South-Tex Corp., and American Republic Corp.

IT takes perception and knowledge to find in advance plans those factors which result in efficient processing.

Proof of perception is in the profit, and Gasoline Plant Construction Corporation has a unique record of installations which confirm GPCC perception with profitable operations.

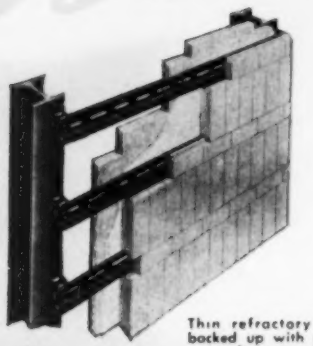
GPCC engineers effect the balance that a successful processing plant must form between field potentials and immediate and ultimate production schedules.

**ENGINEERS • DESIGNERS • CONSTRUCTORS**

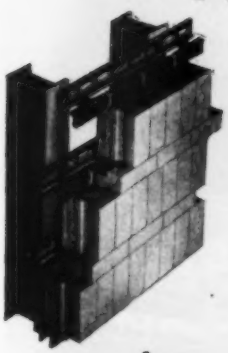
**GASOLINE PLANT CONSTRUCTION CORP.**

NIELS ESPERSON BLDG., HOUSTON WILSON TOWER, CORPUS CHRISTI

# Heavy-duty B-L linings reduce oil still repairs



Thin refractory walls—backed up with insulation—cut the costs of oil still installations. When tile are shaded by tubes, 3" walls are used, 4½" walls are specified for exposed walls of moderate temperatures.



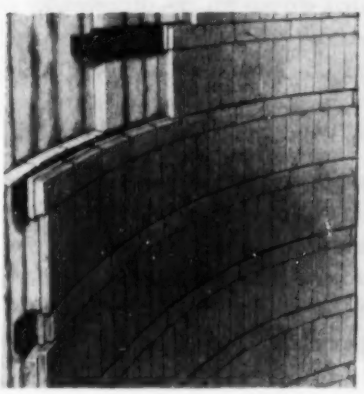
When the going is really tough, B-L engineers select rugged 7" walls. Unit-suspended B-L walls eliminate cumulative loading and expansion. Repairs are to damaged tile, adjacent areas are untouched.

This pendulum-type Bigelow-Liptak arch permits the tile to swing freely in four directions. There is no cumulative loading or expansion thrusts against side walls. Arches are available in any thicknesses, follow any contour. Radial noses are similar.

**Repairs are made quicker and at a much lower cost when oil stills are lined with Bigelow-Liptak walls and arches. Because heavy-duty refractories and insulation are used throughout, B-L linings stand up under the toughest of operating conditions.**

**Refinery boilers are enclosed with special applications of the same type of construction outlined above. When tubes are closely spaced, Bigelow-Liptak's new tube-supported wall is used. Both oil stills and boilers are covered with B-L's casing—TEXAD*. This new covering method is weatherproof, looks better, and replaces steel plate.**

**Catalogs describing refinery furnaces, the tube-supported wall, and TEXAD* are available upon request. Write today**



Here is a Bigelow-Liptak wall curved to fit a 25-foot diameter vessel lining. It is backed up with insulation and is hung from modified circular brackets. B-L walls and arches can follow any furnace contour.

*TRADEMARK

**BIGELOW-LIPTAK Corporation**

and Bigelow-Liptak Export Corporation

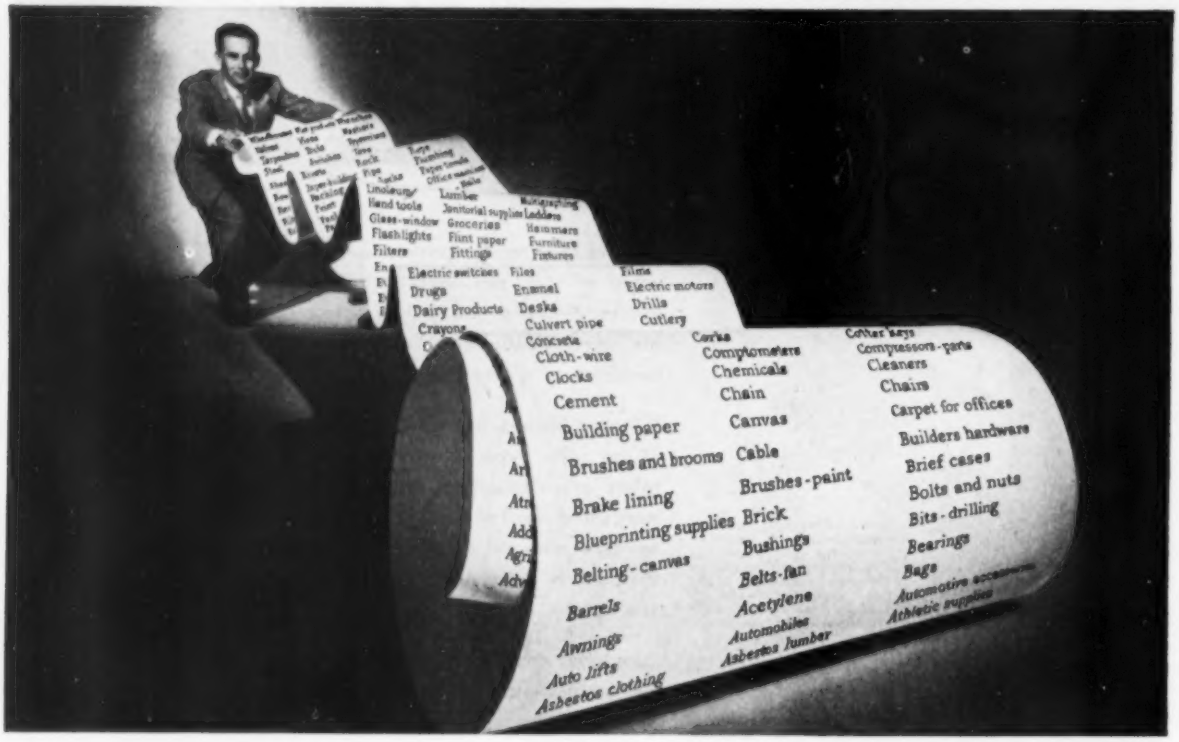
2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

**UNIT-SUSPENDED WALLS AND ARCHES**

*In Canada:* **Bigelow-Liptak of Canada, Ltd., Toronto, Ontario**

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C.

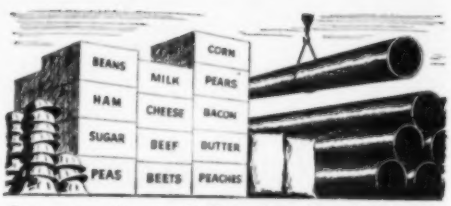
# Short story of a long shopping list



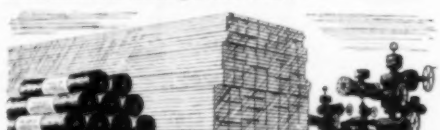

***If you were to jot down*** all the different kinds of goods and services Standard Oil Company of California buys, your shopping list would be about 50,000 items long. Over the years, we've been growing as a *customer* as well as a supplier here in the West.

But the most important aspect of our "shopping," we believe, is *where* we do it. You might think that a large company like Standard would centralize its buying in a few big cities. Actually, our purchases are made in hundreds of Western communities. The almost infinite variety of Standard's needs—from paper clips to propellers, from produce to professional services—has made the Company an important factor in the economic well-being of Western towns and cities.

Last year, once again, Standard was a very good customer for a great many firms—more than 10,000 suppliers, both large and small, to whom we paid more than $125,000,000. We've always bought locally wherever possible and practical. We do it not only because it's good business for Standard, but also because it helps the growth of the West. We know that our long-run prosperity depends on that of the communities we serve.




**From groceries to drilling pipe,** Standard's purchases in local communities mean business to merchants all through the West.



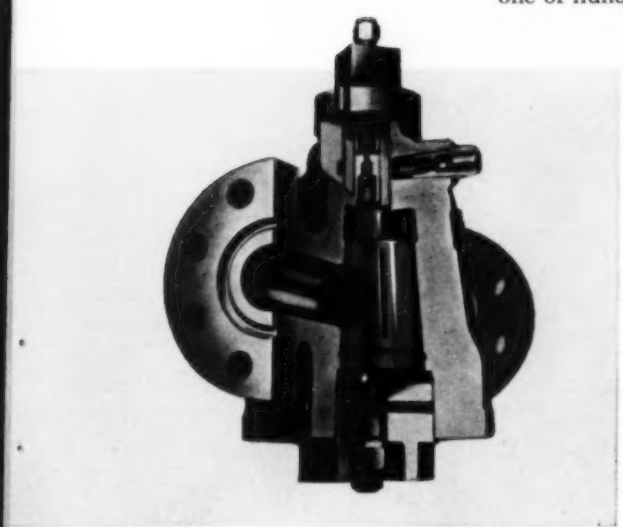
**We buy building materials**—lumber, roofing, plumbing, carpentry, and supplies for our oil fields, refineries, plants, and offices.

**We also use** the services of doctors, nurses, pharmacists, lawyers, engineers, surveyors, drilling contractors, geophysicists and many others.

**STANDARD OIL COMPANY OF CALIFORNIA** ***plans ahead to serve you better***

# HARD-TO-HOLD HYDROCARBONS? Nordstrom *LUBRICANT SEALS* Them

In this case, it's one of the world's largest butane and propane tank batteries that Nordstrom valves are controlling. But it might be any one of hundreds of volatile hard-to-hold hydrocarbons.

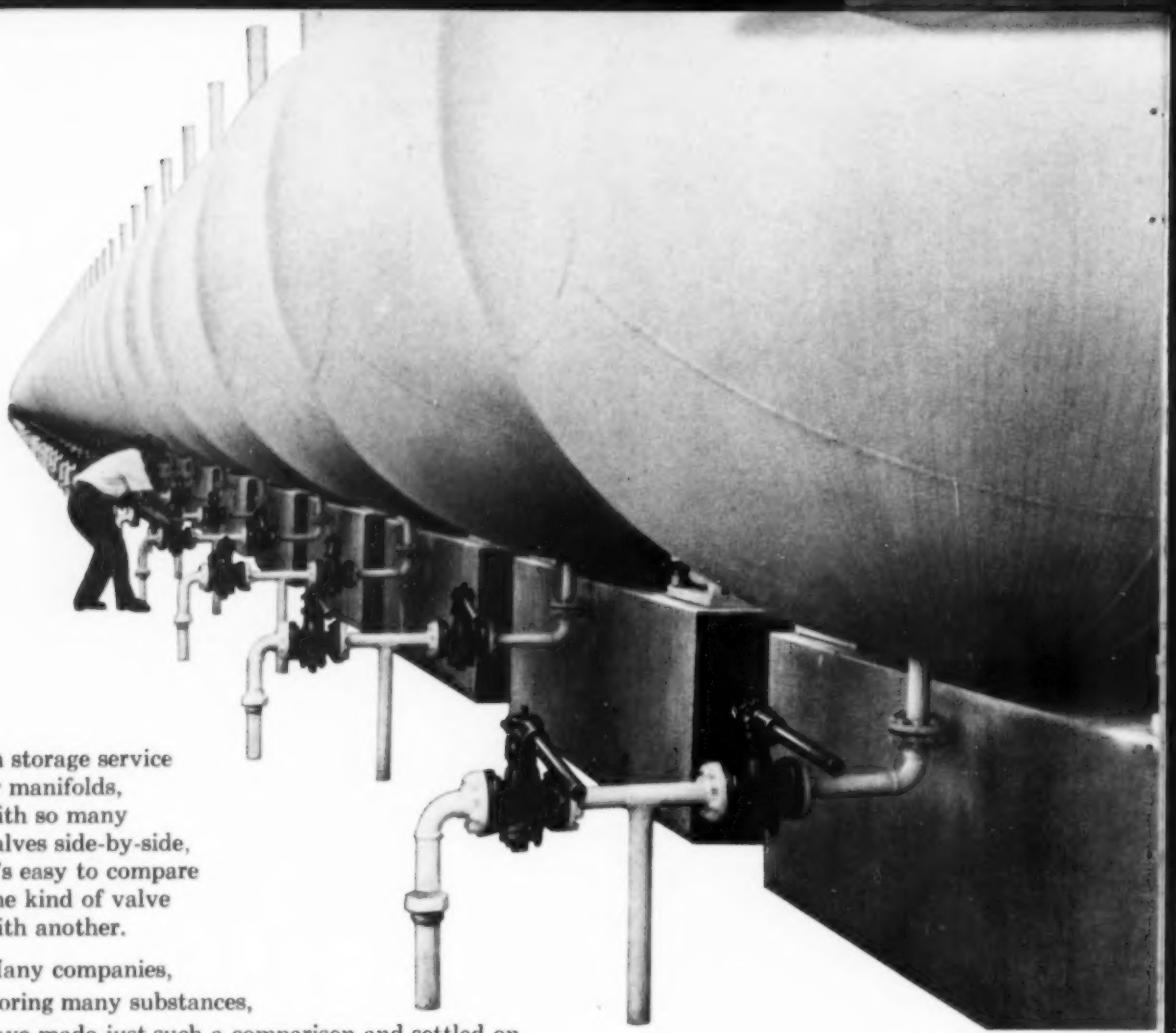


Nordstrom valves don't depend on metal-to-metal contact to check these light, tricky gases and fluids. Nordstrom valves have a seal of plastic lubricant around all seating surfaces—double protection against leaks of inflammable liquids or vapors.

Be sure—really sure. Use Nordstrom valves and genuine Rockwell lubricants. That's the *right* way—that's the *tight* way.
*Rockwell Manufacturing Company, Pittsburgh 8, Pa.*

**ROCKWELL Built**
**Nordstrom Valves**
*Lubricant-Sealed for Positive Shut-Off*

Another ROCKWELL Product



In storage service
or manifolds,
with so many
valves side-by-side,
it's easy to compare
one kind of valve
with another.

Many companies,
storing many substances,
have made just such a comparison and settled on

# NORDSTROM VALVES

Since Nordstrom valves are doubly sealed with an internal film of plastic lubricant, they are doubly protected against the little leaks that can become big dangers. Nordstrom valves operate quickly, too, for it takes only a quarter turn of the plug to change from fully open to fully closed.

# AND ROCKWELL LUBRICANT

. . . the same lubricant that adds to valve tightness, acts as a jack to keep the plug ready to turn. Just as they cut costs in nearly every service to which they've been applied, Nordstrom valves and genuine Rockwell lubricants

# CUT STORAGE COSTS

Remember, the lowest cost valve is not necessarily the cheapest—
it is the valve which does its job best for the longest time.
*Rockwell Manufacturing Company, Pittsburgh 8, Pa.*

**Nordstrom Valves** Another Quality **ROCKWELL** Product

# 100% TURBOGRID, the distillation tray that makes the bubble-cap tray obsolete

A new platformer unit, now on stream at Shell's Houston refinery, is the world's first to be 100% TURBOGRID® equipped.

The 12-column installation includes platforming and Shell Aromatics Recovery sections. The plant produces nitration-grade benzene and toluene, plus a xylene cut.

The columns range up to 163 ft. in height, with diameters up to 10 ft. 6 in. Their cost and performance is another proof that—

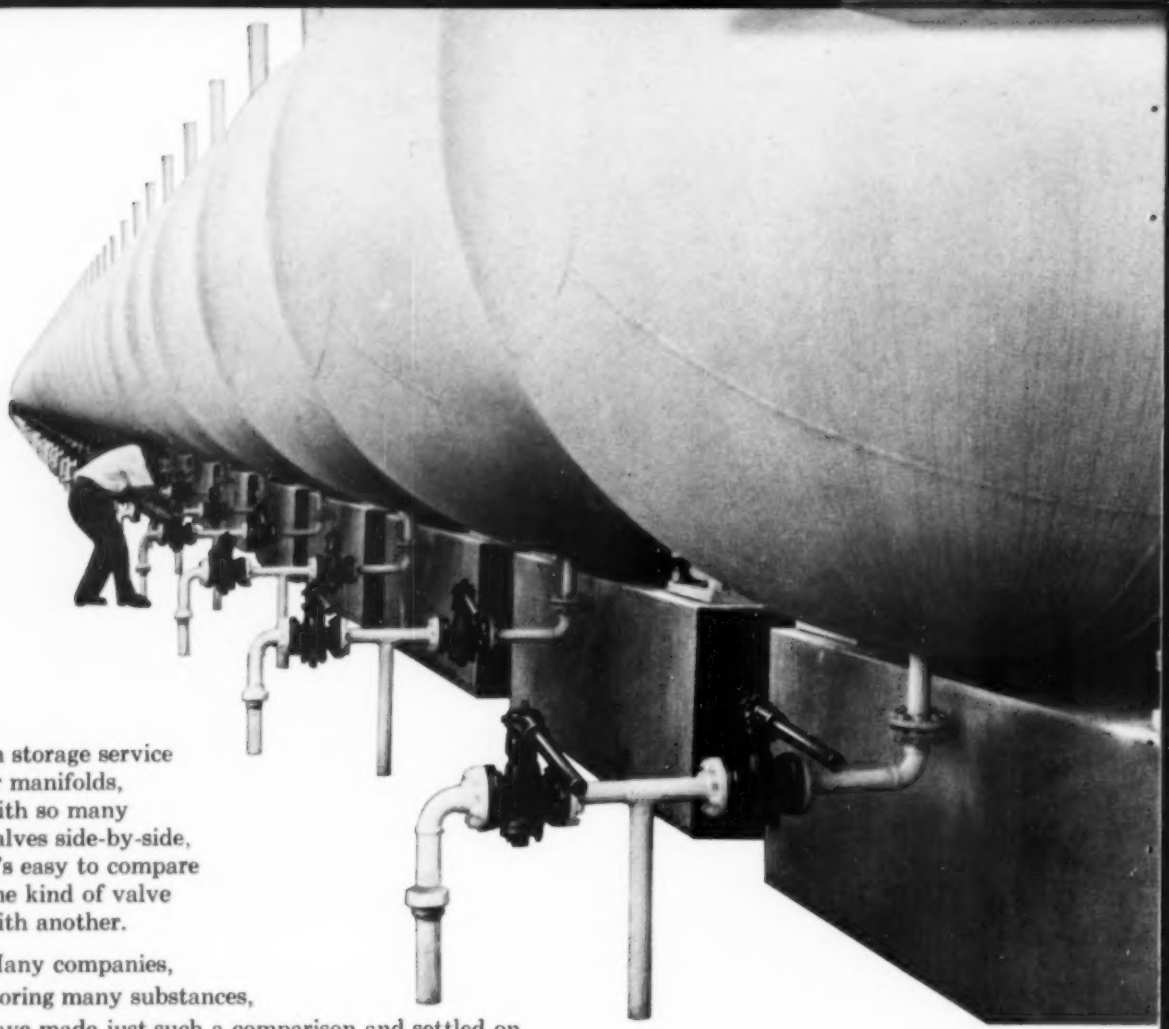
**TURBOGRIDS SAVE MONEY, AND REALLY DELIVER**

TURBOGRID trays can save as much as 50% in the cost of new column construction. Or, replacing your old trays with modern TURBOGRIDS may even double the capacity of existing columns . . . without loss in separating efficiency. Ease of control and operation plus low cost of maintenance . . . pay additional dividends.

TURBOGRID trays are available through accredited contractors under license from Shell Development Co. *Your inquiries are invited.*

**SHELL DEVELOPMENT COMPANY**
**50 WEST 50th STREET • NEW YORK 20, NEW YORK**

SHELL



In storage service
or manifolds,
with so many
valves side-by-side,
it's easy to compare
one kind of valve
with another.

Many companies,
storing many substances,
have made just such a comparison and settled on

# NORDSTROM VALVES

Since Nordstrom valves are doubly sealed with an internal film of plastic lubricant, they are doubly protected against the little leaks that can become big dangers. Nordstrom valves operate quickly, too, for it takes only a quarter turn of the plug to change from fully open to fully closed.

# AND ROCKWELL LUBRICANT

. . . the same lubricant that adds to valve tightness, acts as a jack to keep the plug ready to turn. Just as they cut costs in nearly every service to which they've been applied, Nordstrom valves and genuine Rockwell lubricants

# CUT STORAGE COSTS

Remember, the lowest cost valve is not necessarily the cheapest—
it is the valve which does its job best for the longest time.
*Rockwell Manufacturing Company, Pittsburgh 8, Pa.*

**Nordstrom Valves** Another Quality **ROCKWELL** Product

A new platformer unit, now on stream at Shell's Houston refinery, is the world's first to be 100% TURBOGRID® equipped.

The 12-column installation includes platforming and Shell Aromatics Recovery sections. The plant produces nitration-grade benzene and toluene, plus a xylene cut.

The columns range up to 163 ft. in height, with diameters up to 10 ft. 6 in. Their cost and performance is another proof that—

**TURBOGRIDS SAVE MONEY, AND REALLY DELIVER**

TURBOGRID trays can save as much as 50% in the cost of new column construction. Or, replacing your old trays with modern TURBOGRIDS may even double the capacity of existing columns . . . without loss in separating efficiency. Ease of control and operation plus low cost of maintenance . . . pay additional dividends.

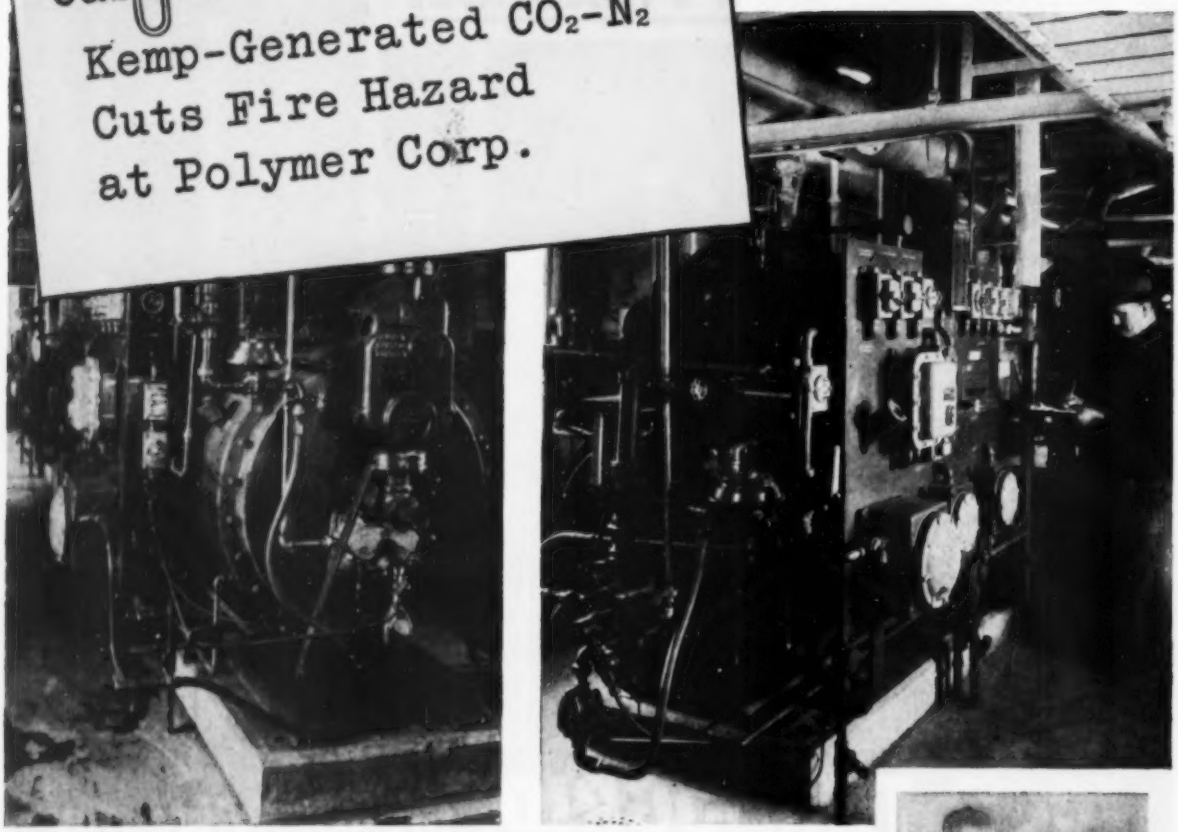
TURBOGRID trays are available through accredited contractors under license from Shell Development Co. *Your inquiries are invited.*

**SHELL DEVELOPMENT COMPANY**
**50 WEST 50th STREET • NEW YORK 20, NEW YORK**

SHELL

Case No. 62

Kemp-Generated $CO_2$-$N_2$ Cuts Fire Hazard at Polymer Corp.



# How Polymer operated day and night for 10 years at maximum safety

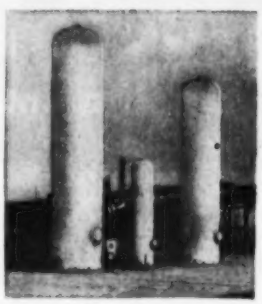
When Polymer Corporation, Ltd., Sarnia, Ontario, began operations in 1943, inventory included two Kemp MIHE Inert Gas Generators. Since that date, Polymer—and its Kemp equipment—has been operating 24 hours a day, 365 days a year. The huge quantities of man-made rubber and associated chemicals it produces—200,000,000 pounds during one year alone—reach, in one form or another, the four corners of the world.

### Kemp Plays an Important Role

The high volatility of many of the ingredients used in this giant operation necessitates blanketing and purging vessels after use. It is in this step that Polymer employs Kemp Generators to assure safe, trouble-free performance. The gas they produce is piped to different operations over the entire company area—it *must* be clean! Kemp does the job—Polymer knows that it can depend on Kemp to deliver a *clean inert at a specific analysis, regardless of demand*. And every Kemp Generator is engineered for fast starts and easy operations that save *time* and *money*.

### Kemp Can Do a Job for You

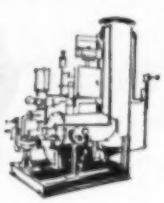
Kemp superiority is no accident. It is based on years of experience . . . on quality of design to meet specific problems. Every Kemp design features the Kemp Industrial Carburetor for complete combustion without tinkering or waste . . . for simplified installation and maintenance. Every Kemp design includes the latest fire checks and safety devices. If you have a blanketing or purging problem, contact Kemp engineers. They will be glad to study your situation and recommend the installation best suited to your needs. No obligation, of course.



**Gas generator building from which inert gas is piped over 130 acres of company property at Polymer's Sarnia, Ontario, operation.**

*For more complete facts and technical information, write for Bulletin I-10 to:* **THE C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

**KEMP OF BALTIMORE**



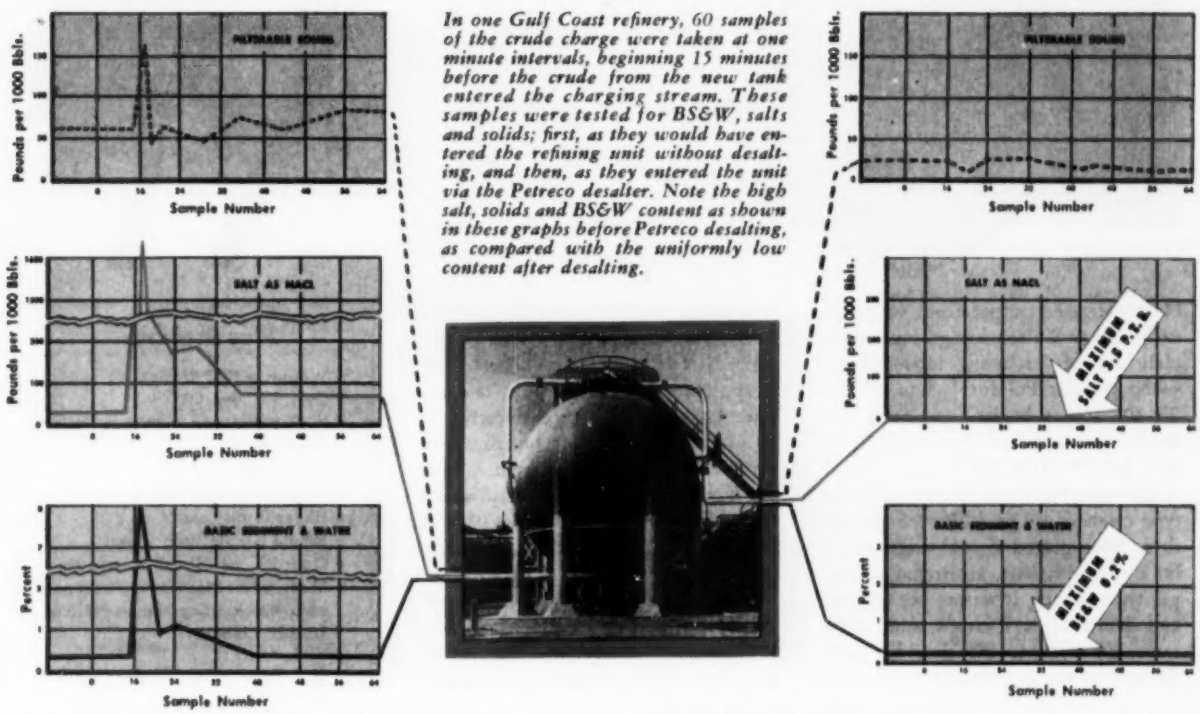
**INERT GAS GENERATORS**

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE DRYERS
SINGEING EQUIPMENT

# ELIMINATE TANK SWITCHING TROUBLE...

When crude is in storage, even low percentages of BS&W settle. A storage tank may have virtually no BS&W in the upper levels, yet have a high concentration of impurities in the bottom. When the tank is put on stream, these higher concentrations often enter the crude charging stream as "slugs" of BS&W. It is in these slugs that salts, solids and other impurities reach the distillation equipment.

**BEFORE DESALTING** **AFTER DESALTING**




*In one Gulf Coast refinery, 60 samples of the crude charge were taken at one minute intervals, beginning 15 minutes before the crude from the new tank entered the charging stream. These samples were tested for BS&W, salts and solids; first, as they would have entered the refining unit without desalting, and then, as they entered the unit via the Petreco desalter. Note the high salt, solids and BS&W content as shown in these graphs before Petreco desalting, as compared with the uniformly low content after desalting.*

*Petreco desalting prevents slugs of BS&W from entering the distillation equipment. Maximum throughput rates can be maintained, upsets avoided, and the end result is more crude refined per calendar day. Get Petreco's new booklet on tank switching*

**Visit Our Exhibit**

**I. P. E. - TULSA - MAY 14-23**

PETROLITE CORPORATION

***PETRECO DIVISION***

3202 S. WAYSIDE DRIVE, HOUSTON 1, TEXAS
1390 E. BURNETT ST., LONG BEACH 6, CALIF.

The slugs of BS&W that enter refining equipment when tanks are switched, bring in salts and solids in high concentrations. In order to compensate for the accompanying difficulties, operators usually cut charge rates during switches. Such procedures may delay salt damage and prevent upsets, but they also cut daily throughput rates and result in less crude refined per calendar day.

# PETRECO

*ELECTRIC PETROLEUM PROCESSING*

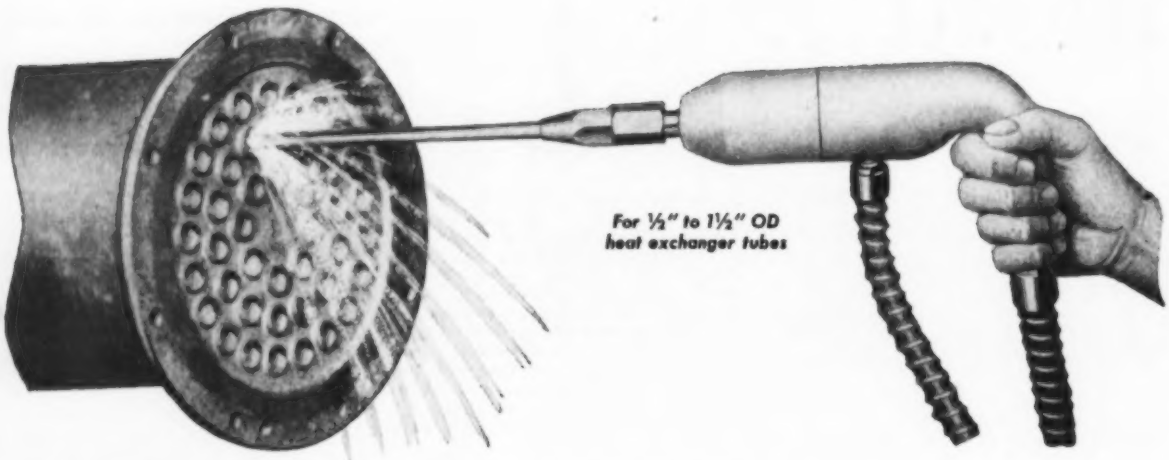
**CRUDE OILS:** REMOVAL OF SALTS, SOLIDS, OTHER IMPURITIES; DEHYDRATING
**DISTILLATES:** ACID TREATING; CAUSTIC TREATING; DOCTOR TREATING
**FUEL OILS:** DESAPONIFICATION, ASH REMOVAL

PS 53-4

# NEW WILSON

## MODEL PGX CLEANER

### *out-performs ordinary types 10 to 1*




Need increased output from your heat exchangers? Wilson brings you a complete line of fast-acting tube cleaners —the popular PG for ⅜" to 1", the TP-301 for up to 2½" . . . and *now* for intermediate sizes, ½" to 1½", the *new* Model PGX Tube Cleaner.

The new PGX out-performs internal type cleaners 10 to 1. It is a positive drive (not geared down) high speed, hollow rotary shaft, air-driven scavenger type cleaner. It washes out the tube and debris while it cleans, and, at the same time, keeps the drill bit cool. There's no worry about jammed, burned out bits, no need for special preparation.

Wilson Model PGX obtains maximum power at 90 psi using 75 cfm at approximately 3,500 rpm. In many cases it will perform satisfactorily at 50 psi. It is suitable for horizontal or vertical applications . . . requires *only one man* to operate. Hollow drill shafts are available in one piece up to 20 feet. Shorter lengths can be coupled by means of taper threads.

Don't struggle along with improvised tools. Use the new PGX Cleaner to minimize downtime. Put fouled equipment back on stream in a hurry.

#### *Plus Features*

- Weighs only 8 lb
- Only 11" overall
- Well balanced . . . with a "man-sized" grip
- Low in cost
- Large scavenger volume
- Fingertip air control
- Simple internal rotary seal
- Operates on 50 psi, if necessary
- Shafts and cutter bits interchangeable with existing Wilson PG and TP-301 Cleaners.

TW 859

**Use the MODEL PGX CLEANER on this equipment**

Water Heaters
Gas Coolers
Glycerine Evaporators
Fuel Oil Heaters
Polymerization Units
Humidifier Tubes
Small Transfer Lines
Miscellaneous Heaters
Miscellaneous Condensers
Miscellaneous Evaporators

**In these plants**

Air Conditioning Plants
Generating Stations
Manufactured Gas Plants
Oil Refineries
Soap Plants
Electro-chem Plants
Paper Mills
Bottling Plants
Food Process Plants
Chemical Process
Pharmaceuticals
Dairies
Process Industries
Fertilizer Plants

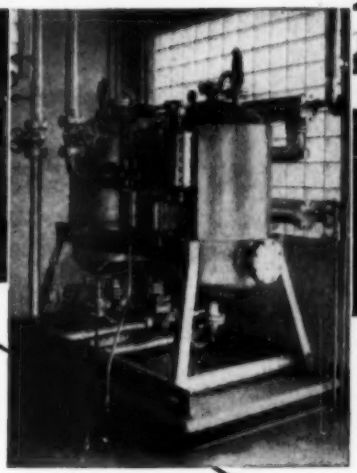
See our Booth #31 at INTERNATIONAL PETROLEUM EXPOSITION TULSA—MAY 14-23, 1953

**WILSON**

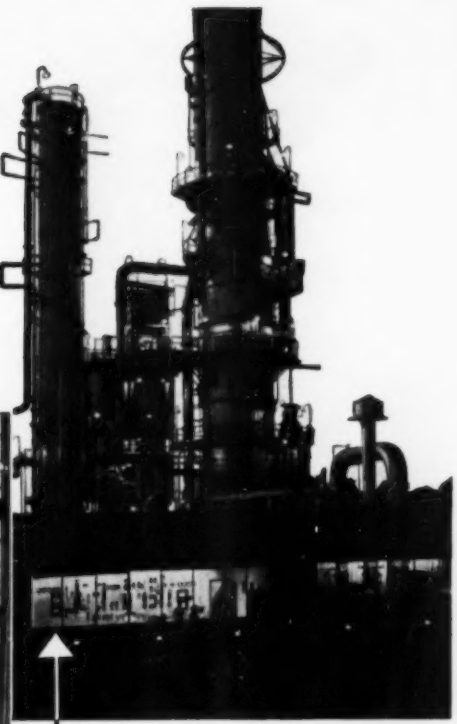
THOMAS C. WILSON, INC., 21-11 44th AVE., LONG ISLAND CITY 1, N. Y.
*Representatives in all principal cities* • *Cable: "Tubeclean" New York*

TUBE CLEANERS • TUBE EXPANDERS

# Lectrodryer* feeds the nerve center DRY AIR only!



Type BY-5 Lectrodryer provides continuous flow of dried air to panels in control room, protecting vital control instruments and lines against moisture. →



Automatically controlled McMurrey Refinery near Tyler, Texas. One operator in the control room can control and watch over its entire operation.

2300 instruments . . . 900 controllers and valves depend on DRY air to put this giant through its paces automatically. If unwanted moisture were to creep into instrument air at the nerve center, the refinery could be thrown haywire! An instrument line freeze-up, rust, scale or sludge clogging tiny ports could cause a long shutdown.

For 24 hours a day a Lectrodryer feeds the nerve center a constant stream of air dried to a dewpoint of -50° F. Moisture doesn't have a chance!

Lectrodryers catch the moisture which separators and filters let by. Throughout the chemical and petroleum industries they dry air, gases and organic liquids . . . automatically, economically, continuously. For extreme dryness there are Lectrodryers drying down to 3 to 4 parts per million or less.

Whatever the drying need, there's probably a Lectrodryer already built to handle it. Our engineers will help you lay out your system and select proper equipment. Write: Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pa.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

**LECTRODRYER**

* REGISTERED TRADEMARK U.S. PAT. OFF.

# *Check* the SAFETY ZONE

Yes . . . check the safety zone before ordering valves. Check . . . for voids in the body that could retain fluid when the valve is closed or open.

LISTED UNDER UNDERWRITERS' LABORATORIES, INC. REEXAMINATION SERVICE UL TYPE "G"

## ORBIT VALVES ®

**ORBIT** Forged Steel LP GAS VALVES are designed so that there are no voids in the body of the Valve, for fluids to become trapped that could feed a fire or contaminate a different product. When the valve is closed it drains clean.

Your Supply Store carries ORBIT Forged Steel Valves in stock. Sizes 1″ to 4″. ASA Ratings 150 lb. Class to and including ASA 2500 lb. Class. Screwed and Flanged Ends. Maximum Rated Working Temperature 250° Fahrenheit.

**BRANCHES**

**HOUSTON, TEXAS,** 407 Velasco
(Serving the Gulf Coast)
**ODESSA, TEXAS,** 402 West County Road
(Serving West Texas)
**CASPER, WYOMING,** 1740 E. Yellowstone
(Serving the Rocky Mountain States and Canada)

**ORBIT VALVE COMPANY**

**P. O. BOX 699** **TULSA, OKLA.**

# [ LETTERS ]

### Oronite, a Pioneer

Dear Editor:

The article in your March, 1953, issue, entitled "Phthalic Acid—Petrochemicals of the Future," by Peter W. Sherwood, has been read with great interest and considerable pleasure by myself and a number of my colleagues in Oronite Chemical Company. I am a little disappointed that Oronite's pioneering production of paraxylene was apparently overlooked. Our first tankcar shipments were made in March, 1950, and production has been significantly expanded since that date.

I would also like to point out that Mr. Sherwood has given at least tacit support to the erroneous conclusion, already widespread in some circles of the chemical industry, that the production of one of the xylene isomers results in the co-production of one or more of the other isomers as a relatively inexpensive by-product. To date, unfortunately, this is not the case, since no one of the isomers is sufficiently completely separated from the mixture of the four $C_8$ aromatic hydrocarbons, but that the quantities which remain behind interfere seriously with the subsequent separation of any one of the other isomers. This has the result that, despite appreciable commercial production of both ortho-xylene and paraxylene, there does not seem to be at the present time any commercially feasible method of production of either metaxylene or ethylbenzene at prices low enough to make them large volume articles of commerce.

R. I. Stirton, Manager
Product Development Department
Oronite Chemical Co.
San Francisco, Calif.

---

Dear Editor:

The points raised by Mr. Stirton are pertinent to the production of terephthalic acid. They were accordingly covered in Part II of my article series, which appeared in the April issue of PETROLEUM REFINER.

Peter W. Sherwood

---

### Lucid Presentation

Dear Sir:

Please accept a verbal pat-on-the-back for R. L. Dudley and Bob Spann for your article on Mid East Oil in the March REFINER. This is a most lucid presentation of an extremely complex problem, and in my opinion it is an outstanding example of objective reporting.

It is regrettable that this article cannot come to the attention of the many who are subjected to the biased viewpoint of groups and organizations with axes to grind. On this subject, as in many other situations, the veil of selfishness effectively obscures objectivity.

The petroleum industry should be indebted to PETROLEUM REFINER for a clear statement of the problem.

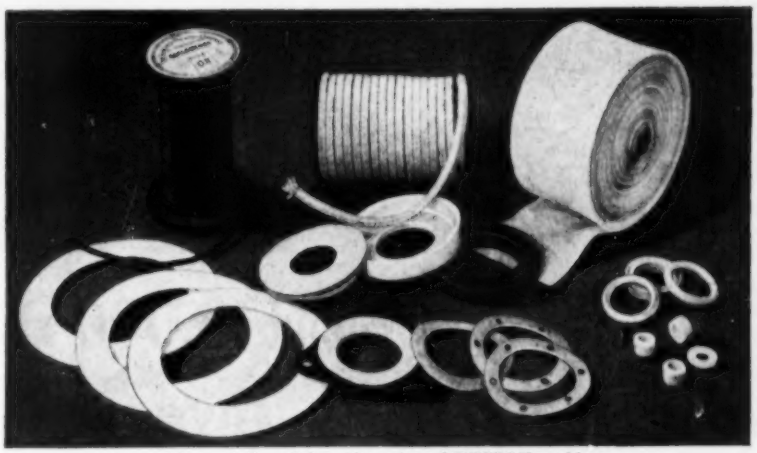
Ike Hall

Baytown, Texas
March 24, 1953


When it comes to

Teflon* PACKINGS and GASKETS

come to Garlock...manufacturers of mechanical packings since 1887



*Above—A few of the wide variety of TEFLON packings and gaskets manufactured in the Garlock factories.*

GARLOCK pioneered in the design and manufacture of packings and gaskets made of TEFLON. Garlock products made of TEFLON are unaffected by acids, organic solvents and other chemicals at operating temperatures from below −90°F. up to 500°F. These packings and gaskets are ideally suited for many other applications due to TEFLON's low coefficient of friction.

We have the facilities to mold, machine, or form TEFLON in a wide variety of shapes and sizes for packing and gasketing. When you need finished TEFLON parts contact your Garlock representative or write for our TEFLON Catalog.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

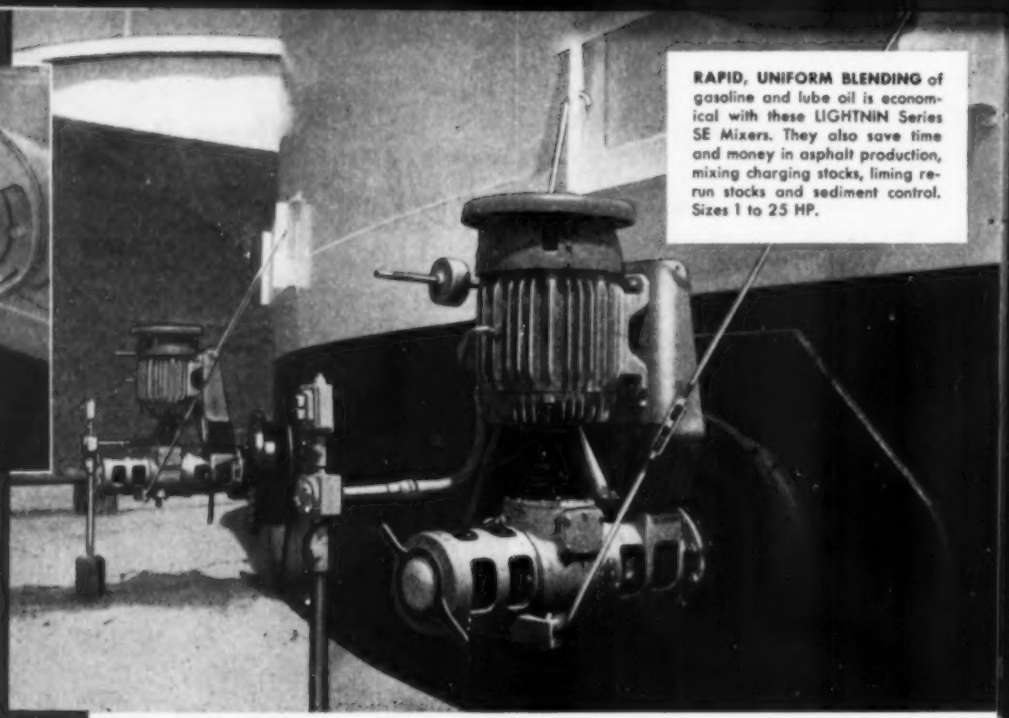
Tulsa, Okla. Houston, Tex.
Los Angeles, Calif.

*The DuPont Company's Trademark

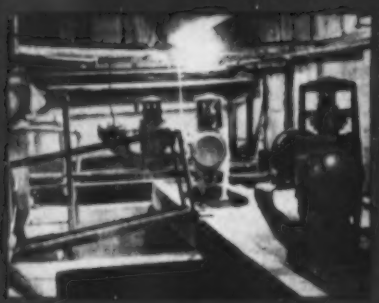
At the Tulsa Oil Show Visit Booths 59-60 in the Texas Building

GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS



**RAPID, UNIFORM BLENDING** of gasoline and lube oil is economical with these LIGHTNIN Series SE Mixers. They also save time and money in asphalt production, mixing charging stocks, liming rerun stocks and sediment control. Sizes 1 to 25 HP.



# Blend 10,000 gal. of lube oil in 20 min

## . . . save up to 50% on HP input

Now you can blend 10,000 gallons of lube oil in only 20 minutes with just one 7½ HP LIGHTNIN Series SE Mixer.

The exceptionally high volumetric flow of these units not only cuts blending time, but assures uniform viscosities with no "dead spots" in the tank.

Yet, this is only one of the applications which can be performed better and faster with these mixers. For example, you can slash hours off gasoline blending and ethylizing time; cut back asphalt in ⅛ the time required by recirculation; uniformly mix charging stocks.

Tank farm operators are also saving thousands of dollars in cleaning costs and storage space, by using these units to control bottom sediment.

### GUARANTEED RESULTS

Best of all, you eliminate guesswork when you use LIGHTNIN Mixers. Thorough, progressive research enables MIXCO to accurately predict your processing results—and guarantee those results or your money back.

Send for Catalog B-104 and get the facts on the savings possible with LIGHTNIN Side Entering Mixers. Mail the coupon today.

**Lightnin® Mixers**

## MIXING EQUIPMENT Co., Inc.

**164 Mt. Read Blvd., Rochester 11, N. Y.**

***In Canada: William & J. G. Greey, Ltd., Toronto 1, Ont.***

- ☐ DH-50 Laboratory Mixers
- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet

Please send me the catalogs checked at left.

Name _____ Title _____

Company _____

Address _____

City _____ State _____

PETROLEUM
REFINER

# The LOOK BOX

**Rags To Riches**

IN OUR FEBRUARY issue, we noted the departure of Mr. Truman from the political scene and, with unrestrained optimism, hailed the arrival of his successor. During his first three months in office, President Eisenhower has given every evidence that this country is indeed progressing from rags to riches in the integrity of its national politics.

We are privileged to witness a widening panorama of change. Evident so far in the actions of the new Administration contrasted to those of its predecessor are:

—Dignified, intelligent statesmanship replacing special privilege, ward-heeling politics,

—Positive, assertive foreign policy in lieu of ill-defined and erratic indecision,

—Unbiased and fair domestic policies instead of purposeless "grease-the-wheel-that-squeaks" handouts.

These principles of sound government have been manifested by the following specific actions: appointment of top-notch business executives to head government agencies, concrete direct action to settle the Korean war, decontrol of prices and materials, and legislative action to return the tidelands to the states.

In short, this heartening turnabout has seen confidence replace confusion, respect instead of derision, and calmness for hysteria.

It was, indeed, time for a change!

**By What Standard?**

A FREQUENT CRITICISM of engineers is their inability to communicate. It is generally assumed that an engineer just scraped by in his English course in college. It is also assumed that he is a very poor public speaker and is too cloistered ever to make a good salesman.

We take issue with these labels, because the standard of reference taken is not the norm but the performance peak. Though not the best, the engineer is far above average in these forms of communication. Isn't it true that some of the best salesmen in the country are engineers? Witness the number of engineers who are solicited as after-dinner speakers (our press release box is full of them). And who would discount the fact that the engineer ranks at the top in the amount of creative report writing on the job (journalists excepted)?

Perhaps the reason for these prejudices is due to the outstanding job the engineer has done in technology. Such achievement creates the idea that he must be equally outstanding in fields either secondary to his job or completely outside his realm. Hence, the standard of reference taken is not the norm but the peak.

Another reason is the complexity of his work. His job represents a studied background and a stimulating experience. To expect him to make all his work understandable to the 12-year-old would be a waste of his time, though it could be attempted. His communications are not generally intended for consumption by the uninitiated.

We are not saying for the engineer to be satisfied with the status quo because we think he can be the best in anything he attempts. Recently, we were able to get some glimpse of how the younger generation is tending in this direction. At a student meeting of the AIChE, we observed ten chemical engineering students deliver technical papers. Though not perfection, we'll stack these ten future engineers against any ten adult speakers at a sales, medical or legal meeting in the country this year!

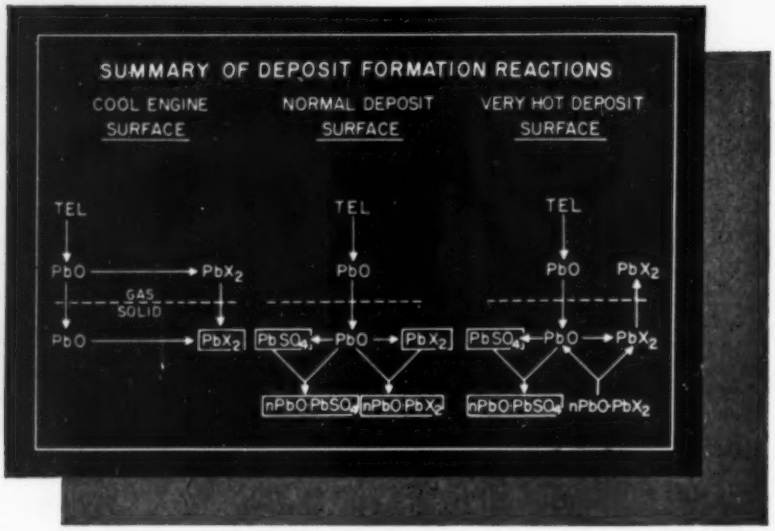
**Special For The Clippers**

MANY OF OUR readers clip PETROLEUM REFINER articles for permanent files. We have long been aware of their problem but doubt seriously that they have any comprehension of the editorial grey hairs provoked by insuring that articles are placed so that they will be clippable.

You see, for an article to be clipped, without taking a part of another article, it must begin on a right-hand page and end on a left-hand page. That means that it must be an even number of pages in length. Now, with no intent whatever of being uncooperative, our authors just plain don't worry about their material being exactly 2, 4, or 6 pages in length. So we do the worrying for them.

The first thing you think of is that we must edit the material so that it is the proper length. We don't do that. If the material is good enough to warrant publication in the PETROLEUM REFINER, then it can't be cut just because of a makeup problem. Here's what we do. First, we try to match the odd-numbered pages with another one that is of high current interest but not expected to have lasting file value. This failing, we draw from a very select group of one-page articles which have been most inappropriately labeled "fillers." The name is inappropriate because it implies that the material is not of the usual quality of the other articles. Actually, they represent some

**THIS CHART SHOWS** the compounds found in the deposit and the reactions by which they are produced under each of the temperature conditions studied.




## New studies reveal

# The sequence of chemical reactions which occur in engine deposit formation

Combustion chamber deposits, which increase the tendency of fuels to knock, have long presented a problem to petroleum engineers working on the improvement of fuel performance.

Until recently, however, very little was known about the reaction mechanisms which result in the accumulation of these deposits—especially with fuels containing tetraethyl lead. And nearly all modern automotive fuels contain this antiknock compound.

**SINCE DU PONT** is a large supplier of tetraethyl lead, the Du Pont Petroleum Laboratory recently undertook a study of the sequence of chemical reactions which occur in combustion chamber deposit formation.

Although almost all tetraethyl lead decomposition products are removed from the combustion chamber with the exhaust gases, a small amount remain on the chamber walls in the form of inorganic lead salts.

Engine deposits also contain a certain amount of carbonaceous materials from incomplete combustion, and both metallic and nonmetallic compounds introduced with the air, fuel or oil, and from engine wear.

**THESE DU PONT STUDIES**—part of a continuing series of systematic investigations on the mechanisms causing combustion chamber deposits—were limited to the formation of the lead salt portion of the deposits.

The results are summarized in the chart above. For full details on the results and their significance, ask any Du Pont Petroleum Chemicals representative or district office for a copy of "The Mechanism of Combustion Chamber Deposit Formation with Leaded Fuels."

DU PONT
REG. U.S. PAT. OFF.

**Better Things for Better Living**
*. . . through Chemistry*

# Petroleum Chemicals

**E. I. DU PONT DE NEMOURS & COMPANY (INC.)**
*Petroleum Chemicals Division • Wilmington 98, Delaware*

*District Offices:* New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

*District Laboratories:* Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.—Calgary, Alta.

of the best material presented in our pages.

In any event, just for your passing interest, that's the story of how a single phase of our business is conducted with the aim of making the PETROLEUM REFINER more valuable to you.

**Improvement in Product Inventory**

IMPROVEMENT HAS been made in the industry's refined product inventory situation during the past several months. As a result, there is a greater feeling that stocks can be prevented from becoming excessive by careful limitation of crude production and refining rates during the next several months.

Greatest improvement has taken place in gasoline stocks, which no longer threaten to become excessive, and which were only about ½ million barrels greater late in April than they had been a year earlier. These stocks had been 5 million barrels more just a month ago. Early Spring-like weather in most sections of the country has hastened the up-surge in motoring and farming demand for motor fuel.

Distillate fuel stocks, still suffering from the warmest winter in recent years, were 12⅓ million barrels higher at the end of the third week of April than they had been a year earlier. All this means that the industry must exercise extreme caution in its production of these heating oils between now and next November, when they will again become widely needed.

With the running-start that the gasoline season has had, it is quite apparent that a continued strong demand for this product will continue. Refiners will be able to hold their rates at reasonably high levels, but must adjust their yields to produce more gasoline at the expense of the heating oils to prevent accumulations from becoming excessive.

The industry has a very good opportunity to establish a better balanced economic position if its crude producing, crude and products importing, and refining rates are held to a lower plane during the next two or three months.

**Too Many Chiefs**

SOME OF THE major companies have overdone it in screening out technical employes with the result that they have "too many chiefs and not enough Indians." All employers place a value on qualities for potential executives when considering new technical men. Many organizations have established this as the No. 1 requirement. Thus has come about the situation of technical organizations overloaded with prime executive talent and no place to use it.

We would like to propose a radical departure from conventional thinking on the subject and postulate that every good technical organization must have men who are *not* potential executives. Certainly none of us kids ourself into believing that engineering is all romance—in every branch of the profession there are numerous problems that place a premium on the "plugging" type of employe. This is the man who is not deflated by detail and repetitive calculations, a man who actually prospers in a type of work that involves a minimum of decisions. A well-balanced group needs this type of engineer to complement the talents of future executives.

**Subsidize Avgas?**

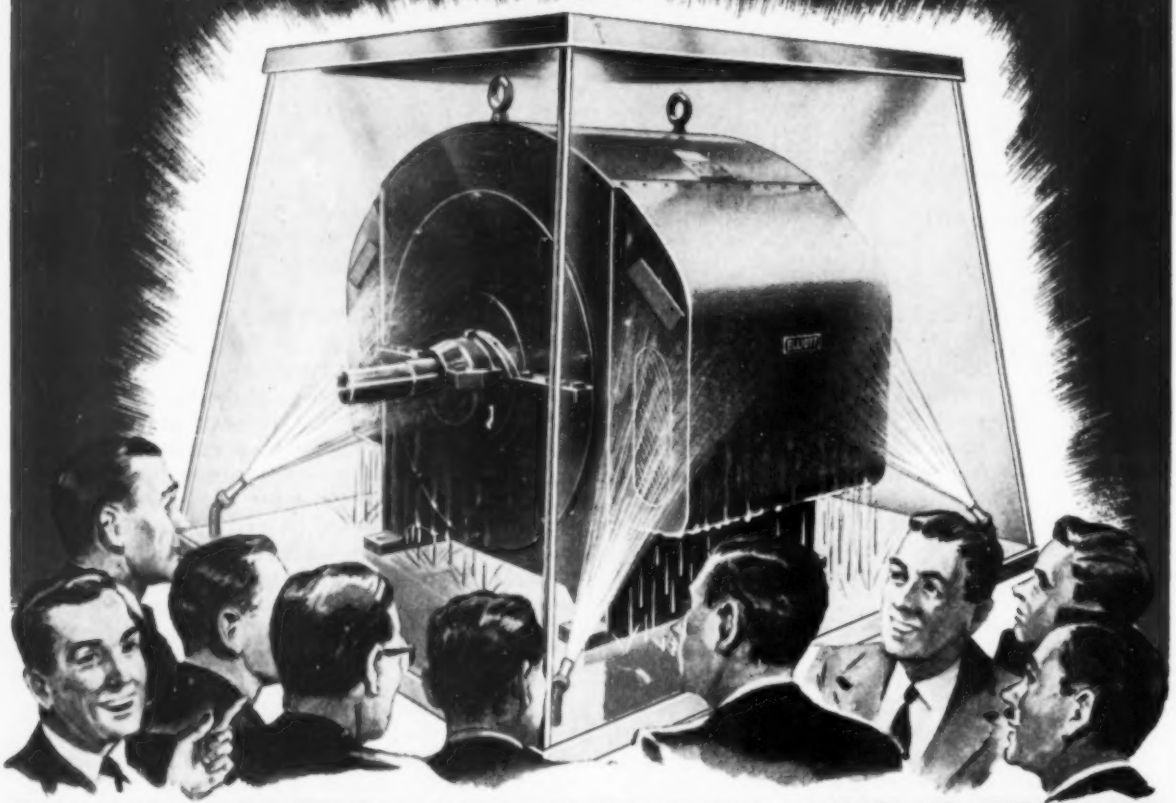
THE NATION'S aviation gasoline picture looks hopelessly befuddled. Uncle Sam is putting all sorts of heat on the refiners to build more avgas facilities. The refiners don't want to do it because it is a high risk operation. The prime equipment—alkylation—can't be used for anything else. Thus if the demand for avgas went down, precious millions would be tied up in idle equipment. That's exactly what happened after World War II. With jet planes becoming increasingly numerous, the demand potential for conventional avgas is even more uncertain.

What's the answer? The government has two possibilities, one of which is already a reality. First, it can offer fast tax writeoffs. In effect, this forces the refinery to gamble that taxes will come down in the future. With accelerated amortization, the refiner depreciates his equipment over five years instead of the conventional 15 or 20. If taxes are reduced at the end of the five-year period, he has come out fine. He has claimed his depreciation allowance (as operating expense) at the time when the tax rates were the highest. If taxes go up, he's hooked. When his five years are out, he no longer can claim depreciation at the time he needs it most with the higher tax rate. Over the last 100 years, taxes have gone steadily upward, so it doesn't look like a particularly attractive gamble. Of course, higher depreciation rates now do release capital for additional investment in profit-making ventures.

The second possibility is for the government to outright subsidize the new facilities, possibly through the RFC. The sugar-coating on this pill is a little thin, too. The bleak shadow of governmental regulation has been moving increasingly closer to the oil industry. A subsidized plant is operated under government regulation and supervision, which means that Uncle Sam keeps a mighty persistent finger in the pie. To an industry that prides itself on rugged independence, this is an unattractive picture.

To sum it all up, there is a potential need for aviation gasoline in the interest of the national defense. It is not economically attractive for the nation's refiner to satisfy that need. Federal help is a totally mixed blessing. There must be a solution—can you suggest one?

# It operates in a constant deluge



# ELLIOTT *OUTDOOR SPLASHPROOF WEATHER-PROTECTED* MOTOR

*See it at the oil show!*

**International Petroleum Exposition and Congress, Tulsa, May 14-23.**

SEE A MAN-MADE STORM shoot four heavy sprays of water right into the ventilating inlets and discharge openings of an operating motor to demonstrate the most complete moisture separation ever designed into an open-type motor. See the dust protection too—integrally designed non-clogging filters, easily removable for cleaning without stopping the motor.

See this revolutionary motor design which has made industrial history since World War II. An engineer's dream in 1946, it has grown to a major factor in present-day cost-saving station and plant design in utilities and many industries. This all-weather design has triumphed over conditions regardless of where installed—in salt spray and fog on both coasts—in hot humid areas of the southeast—in hot dusty desert conditions of the southwest—in extreme cold and snow of the north.

If you have cost-of-construction problems—yet you cannot sacrifice reliability—then stop by the Elliott booth, No. 125-126 Oklahoma Building, at the Oil Show and discuss your problems with the people who pioneered the outdoor splashproof motor; or write Elliott Company, Ridgway, Pa.

Elliott FABRI-STEEL MOTORS AND GENERATORS

## ELLIOTT Company

### RIDGWAY DIVISION

83-18

FOR MOTORS 1-200 HP. CROCKER WHEELER DIV. AMPERE, N. J.

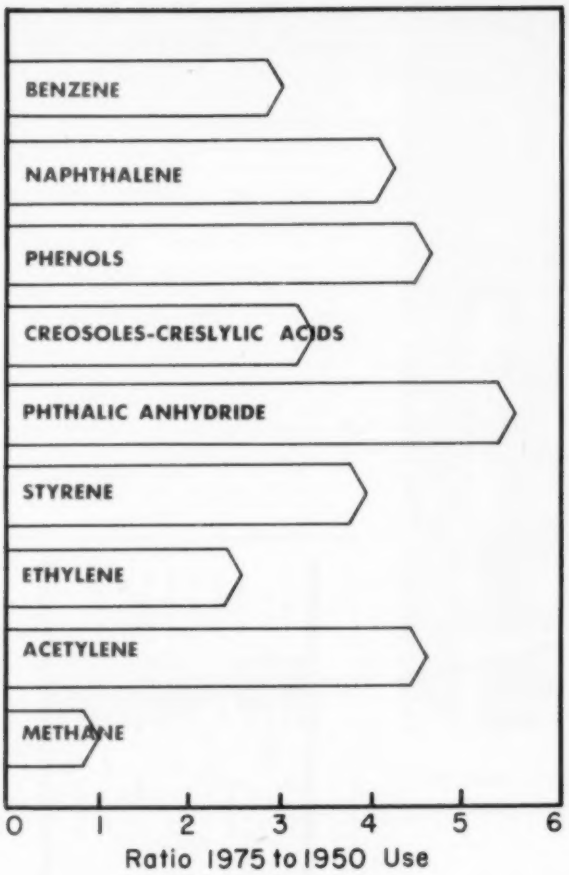



**TABLE 1**
**Production of Tar Crudes**

| Reference | | PRODUCTION, Million of Gallons | | | RATIO | |
|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 |
| | **Benzene, Except Motor Grade** | | | | | |
| 1 | From Coal Carbonization | 176 | 203 | 234 | 1.2 | 1.3 |
| 2 | From Coal Hydrogenation | 0 | 34 | 34 | | |
| 3 | From Petrochemical Sources | 10 | *71 | 689 | 7.1 | 68.9 |
| 4 | TOTAL | 186 | 308 | 957 | 1.7 | 5.1 |
| | **Motor Benzol, Million Gallons** | | | | | |
| 5 | From Coal Carbonization | 14 | N.A. | N.A. | ... | ... |
| 6 | From Coal Hydrogenation | N.A. | 10 | 11 | ... | ... |
| | **Toluene, Million Gallons**** | | | | | |
| 7 | From Coal Carbonization | 38 | 42 | 49 | 1.1 | 1.3 |
| 8 | From Coal Hydrogenation | 0 | 60 | 60 | ... | ... |
| 9 | From Petrochemical Sources | 45 | N.A. | N.A. | ... | ... |
| 10 | TOTAL | 83 | N.A. | N.A. | ... | ... |
| | **Xylenes, Million Gallons** | | | | | |
| 11 | From Coal Carbonization | 10 | 16 | 19 | 1.6 | 1.9 |
| 12 | From Coal Hydrogenation† | 0 | 68 | 68 | ... | ... |
| 13 | From Petrochemical Sources† | 62 | 12 | 235 | 0.2 | 3.8 |
| 14 | TOTAL XYLENES | 72 | 96 | 322 | 1.3 | 4.5 |
| 15 | As Ortho (Only if there is Insufficient Napthalene for Phthalic Anhydride) | N.A. | 37 | 94 | ... | ... |
| 16 | As Para for Synthetic Fibers | N.A. | 4 | 104 | ... | ... |
| 17 | Others & Mixtures | N.A. | 55 | 124 | ... | ... |
| | **Solvent Naphtha** | | | | | |
| 18 | From Coal Carbonization | 6 | 6 | 7 | 1.0 | 1.2 |
| 19 | From Coal Hydrogenation | 0 | 0 | 2 | ... | ... |
| 20 | TOTAL | 6 | 6 | 9 | 1.0 | 1.5 |
| | **Naphthalene, Crude** | | | | | |
| 21 | From Coal Carbonization | 289 | 529 | 705 | 1.8 | 2.4 |
| 22 | From Coal Hydrogenation | 0 | 114 | 114 | ... | ... |
| 23 | Other Sources, Probably Mainly Imports | 166 | 57 | 1751–2501 | 0.3 | 10.5–15.1 |
| 24 | TOTAL | 455 | 709 | 2570–3320 | 1.5 | 5.6–7.3 |

* Another Forecast is 200-250 Million Gallons.

** Another Forecast of Demand Excluding TNT, Million Gallons: (1955) 68; (1975)145.

† Should be Considered as Alternatives.

# Synthetic Organic Chemicals In 1975

## Tables show more clearly than Materials Policy Commission report what 1955 and 1975 production will be in comparison with 1950

TO WHAT LEVEL of production will synthetic organic chemicals rise by 1955 and by 1975? Such a question, seemingly unanswerable in view of the rapid production growth in the last ten years, must be faced by the industry because of petroleum's stake in raw materials.

Within the five volumes of the report of the Materials Policy Commission is presented considerable data on the production of synthetic organic chemicals over the next 25 years. Because this material is not purposely collated or organized, the author here presents a set of tables in which an attempt is made to organize the data in a more systematic fashion and compare it with the statistics for 1950.

The estimates presented were arrived at by personnel selected from the chemical industry who made estimates based on an assumed state of the future economy, as seen by the Materials Policy Commission.

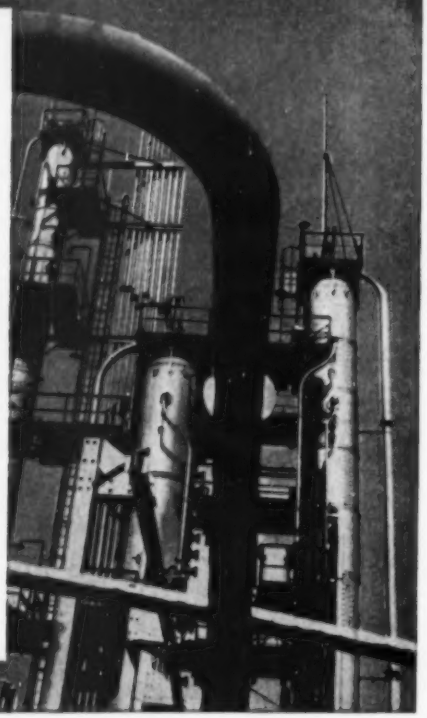
Assumptions were made with regard to the state of the economy in 1975 as follow:

1) An assumed population of 193 million.
2) A working force of 82 million.
3) A gross national product of $556 billion (in dollars having a purchasing power value of the 1950 dollar). The gross national product in 1950 was about half of this figure, or $284 billion.
4) An increase of from 50 to 60 percent in the total supply of industrial raw materials (which may require the importing of $3 billion worth of raw materials per year).

At best, this procedure is a "guesstimate" of future needs in production. The errors that might be involved in such a procedure are obvious. It may be pertinent at this point to quote a comment on these estimates which appeared recently in the Guaranty Survey (Guaranty Trust Company, New York, August, 1952, p. 2).

"Although the assumptions underlying these forecasts are reasonable the commission recognizes that, in attempting to project economic trends a quarter of a century into the future, it is on shaky ground. It disclaims any inten-

# YOU CAN STOP liquid carry-over in processing vessels WITH METEX MIST ELIMINATORS



The unusually high efficiency with which these *knitted* wire mesh units remove the liquid entrainment that occurs in a wide variety of refining and processing operations has enabled engineers to:

1. Improve product quality and eliminate reruns.
2. Prevent contamination in subsequent operations.
3. Recover valuable products previously lost.
4. Operate existing equipment at higher capacities.
5. Design new equipment with smaller dimensions.
6. Achieve more economical processing of lower grade materials.
7. Secure longer "on-stream" periods by removing corrosive liquids.
8. Prevent air pollution by objectionable liquids.

**METEX** Mist Eliminators can be used *wherever* the problem of liquid entrainment exists. By effecting complete removal of liquids, Mist Eliminators contribute to more efficient and economical processing in such vessels as:

| | | |
|---|---|---|
| VACUUM PIPE STILLS | EVAPORATORS | COMPRESSORS |
| FRACTIONATING TOWERS | ABSORBERS | SEPARATORS |
| KNOCK-OUT DRUMS | SCRUBBERS | STEAM DRUMS |

**Get the full facts on METEX Mist Eliminators**

Write for bulletins giving detailed information — including limiting velocities, pressure drop, efficiencies, etc.

**METAL TEXTILE CORPORATION**

KNITTERS OF WIRE MESH FOR MORE THAN A QUARTER CENTURY

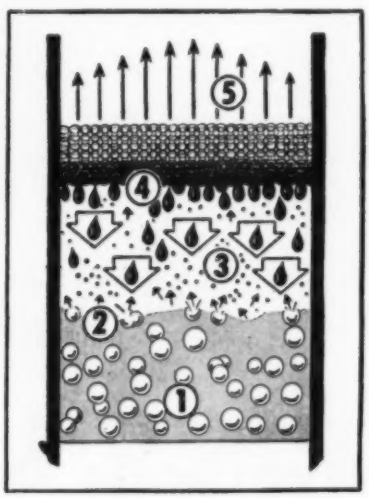
Main Office & Plant, Roselle, New Jersey — Canadian Plant, Hamilton, Ont.


## *Pads of Knitted Wire Mesh Wipe Out Liquid Entrainment*

Pads of uniform density, made from multiple layers of knitted wire mesh, have proved exceptionally effective in removing liquid entrainment from gases in a wide range of refining and processing operations.

The pad is placed inside a vessel above the liquid level. Its construction provides a multiplicity of unaligned, asymmetrical openings with unusually large wire-surface area. It is impossible for a gas to pass through the pad without continually changing direction; yet the high free volume—97 to 98%—minimizes restriction and pressure drop.

### Method of Operation




When a gas is generated in or passes through a liquid (1), it carries with it, as it bursts from the liquid surface (2), a fine spray of droplets of entrained liquid. These droplets are carried upward by the rising gas stream (3).

As the gas passes through the pad, the droplets impinge on the extensive wire surface (125 square feet of area per cubic foot of pad volume). The droplets coalesce on the wire surface to form large drops of liquid which break away (4) from the wire mesh and fall back against the gas stream. The gas (5) passes on, freed from liquid entrainment.

### Availability

The pads, which are known as METEX Mist Eliminators, are made by Metal Textile Corporation, 633 East First Avenue, Roselle, N. J. A bulletin giving detailed information is available on request from the manufacturer.

(Adv.)

**TABLE 2**

**Estimated Use of Benzene**

(7.3 Pounds = 1 Gallon)

(Excluding Military Aviation Gasoline)

| Reference | Use In: | CONSUMPTION, Millions of Gallons | | | RATIO | | |
|---|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 | 1975–1955 |
| 25 | Phenol | 41 | 82 | 385 | 2.0 | 9.4 | 4.7 |
| 26 | Styrene | 65 | 94–107 | 206–476 | 1.4–1.6 | 3.2–7.3 | 2.1–4.4 |
| 27 | Aniline | 14 | 18 | 27 | 1.3 | 1.9 | 1.5 |
| 28 | Nylon | 20 | 30 | 30 | 1.5 | 1.5 | 1.0 |
| 29 | DDT | 5 | 7 | 50 | 1.4 | 10.0 | 7.0 |
| 30 | Diphenyls | 3 | 5 | 10 | 1.7 | 3.3 | 2.0 |
| 31 | Maleic Anhydride | 3 | 5 | 30 | 1.7 | 10.0 | 6.0 |
| 32 | Synthetic Detergents | 10 | 18–25 | 42–50 | 1.8–2.5 | 4.2–5.0 | 2.3–2.0 |
| 33 | Dichlorobenzenes | 5 | 7 | 10 | 1.4 | 2.0 | 1.4 |
| 34 | Monochlorobenzene (Other than DDT, Phenol & Aniline) | 5 | 7 | 10 | 1.4 | 2.0 | 1.4 |
| 35 | Nitrobenzene (Other than Aniline) | 4 | 6 | 9 | 1.5 | 2.3 | 1.5 |
| 36 | Others | 12 | 20–116 | 62–101 | 1.7–9.7 | 5.2–8.4 | 3.1–0.9 |
| 37 | TOTAL | 187 | 299–415 | 871–1188 | 1.6–2.2 | 4.7–6.4 | 2.1–4.0 |
| 38 | Benzene Hexachloride (Included above with Phenol) | 2 | 9 | NA | 4.5 | ... | ... |
| 39 | Phenolic Resins (Included above with Phenol) | 27 | 48–55 | 105–276 | 1.8–2.0 | 3.9–10.2 | 2.2–5.0 |
| 40 | In DDT, Benzene Hexachloride, and 2,4D (Another Forecast) | ... | 22 | 34 | ... | ... | 1.5 |
| 41 | Total Synthetic Fibers | 20 | 55 | 161 | 2.8 | 8.0 | 2.9 |
| 42 | GRS Synthetic Rubber (Included above with Styrene) | ... | 37 | 34 | ... | ... | 0.9 |

**TABLE 3**

**Estimated Use of Naphthalene**

| Reference | Use In: | CONSUMPTION, Millions of Pounds | | | RATIO | | |
|---|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 | 1975–1955 |
| | **Crude Naphthalene** | | | | | | |
| 43 | Phthalic Anhydride | 335 | 550 | 2310–3060 | 1.6 | 6.9–9.1 | 4.2–5.6 |
| 44 | Refined Naphthalene | 120 | 150 | 260 | 1.3 | 2.2 | 1.7 |
| | TOTAL CRUDE | 455 | 700 | 2570–3320 | 1.5 | 5.6–7.3 | 3.7–4.7 |
| | **Refined Naphthalene** | | | | | | |
| 46 | Dyes & Intermediates | 64 | 80 | 150 | 1.3 | 2.3 | 1.9 |
| 47 | Moth Repellents | 19 | 24 | 30 | 1.3 | 1.6 | 1.3 |
| 48 | Surfactants | 6 | 8 | 16 | 1.3 | 2.7 | 2.0 |
| 49 | Leather | 6 | 8 | 10 | 1.3 | 1.7 | 1.3 |
| 50 | Other | 5 | 8 | 10 | 1.6 | 2.0 | 1.3 |
| | TOTAL | 100 | 228 | 216 | 2.3 | 2.2 | 0.9 |

**TABLE 4**

**Production of Cyclic Intermediates**

| Reference | | PRODUCTION, Millions of Pounds | | | RATIO | | |
|---|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 | 1975–1955 |
| | **Cresols** | | | | | | |
| 52 | From Coal Carbonization | 19 | 27 | 38 | 1.4 | 2.0 | 1.4 |
| 53 | From Coal Hydrogenation | 0 | 49 | 1290 | ... | ... | 26.3 |
| 54 | TOTAL | 19 | 76 | 1328 | 4.0 | 69.9 | 17.5 |
| | **Cresylic Acid, Refined** | | | | | | |
| 55 | From Coal Carbonization | 13 | 18 | 26 | 1.4 | 2.0 | 1.4 |
| 56 | From Petrochemical Sources | 24 | 72 | 149 | 3.0 | 6.2 | 2.1 |
| 57 | TOTAL | 37 | 90 | 175 | 2.1 | 4.7 | 1.9 |
| 58 | **Naphthalene, Refined** | 84 | 125 | 216 | 1.5 | 2.6 | 1.7 |
| | **Phenol** | | | | | | |
| 59 | From Coal Carbonization | 20 | 28 | 40 | 1.4 | 2.0 | 1.4 |
| 60 | From Coal Hydrogenation | 0 | 50 | 1350 | ... | ... | 27.0 |
| 61 | From Chemical Synthesis | 292 | 522 | 1416 | 1.8 | 4.8 | 2.7 |
| 62 | | 312 | 600 | 2806 | 1.9 | 9.0 | 4.7 |
| 63 | **Phthalic Anhydride** | 216 | 400 | 2192 | 1.9 | 10.1 | 5.5 |
| 64 | **Picolines** | 0.5 | 0.6 | 1.0 | 1.2 | 2.0 | 1.7 |
| 65 | Pyridine, Refined | 1.8 | 2.2 | 2.8 | 1.2 | 1.6 | 1.3 |
| 66 | Quinoline, Refined | 0.4 | 0.5 | 0.8 | 1.3 | 2.0 | 1.6 |
| 67 | Styrene | 539 | 1000 | 3935 | 1.9 | 7.3 | 3.9 |
| | (Note: Ethyl Benzene from Coal Hydrogenation, Million Gallons) | (0) | (0) | (12) | ... | ... | ... |

**TABLE 5**

**Estimated Use of Cresols and Cresylic Acids**

| Reference | Use In: | CONSUMPTION, Millions of Pounds | | | RATIO | | |
|---|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 | 1975–1955 |
| 68 | Phenolic Resins | 34 | 68 | 340 | 2.0 | 10.0 | 5.0 |
| 69 | Tricresyl Phosphate Plasticiser | 16 | 17 | 21 | 1.1 | 1.3 | 1.2 |
| 70 | Ore Flotation | 10 | 12 | 20 | 1.2 | 2.0 | 1.7 |
| 71 | Disinfectants | 8 | 9 | 13 | 1.1 | 1.6 | 1.4 |
| 72 | Carbon Removal from Engines | 6 | 7 | 11 | 1.2 | 1.8 | 1.6 |
| 73 | Lubricating Oil Refining | 6 | 8 | 16 | 1.3 | 2.7 | 2.0 |
| 74 | Lubricating Oil Additives | 5 | 7 | 15 | 1.4 | 3.0 | 2.1 |
| 75 | Textile Processing | 2 | 3 | 7 | 1.5 | 3.5 | 2.3 |
| 76 | Others | 3 | 4 | 5 | 1.3 | 1.7 | 1.3 |
| 77 | | 90 | 135 | 448 | 1.5 | 5.0 | 3.3 |

**TABLE 6**

**Estimated Use of Phenol**

| Reference | Use In: | CONSUMPTION, Millions of Pounds | | | RATIO | | |
|---|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 | 1975–1955 |
| 78 | Phenolic Resins | 195 | 400 | 1950 | 2.0 | 10.0 | 4.9 |
| 79 | Chemicals | 70 | 148 | 780 | 2.1 | 11.1 | 5.3 |
| 80 | Solvent Refining | 15 | 18 | 30 | 1.2 | 2.0 | 1.7 |
| 81 | Export | 14 | 14 | 14 | 1.0 | 1.0 | 1.0 |
| 82 | Other | 17 | 20 | 32 | 1.2 | 1.9 | 1.6 |
| 83 | | 311 | 600 | 2806 | 1.9 | 9.0 | 4.7 |

**TABLE 7**

**Estimated Use of Phthalic Anhydride**

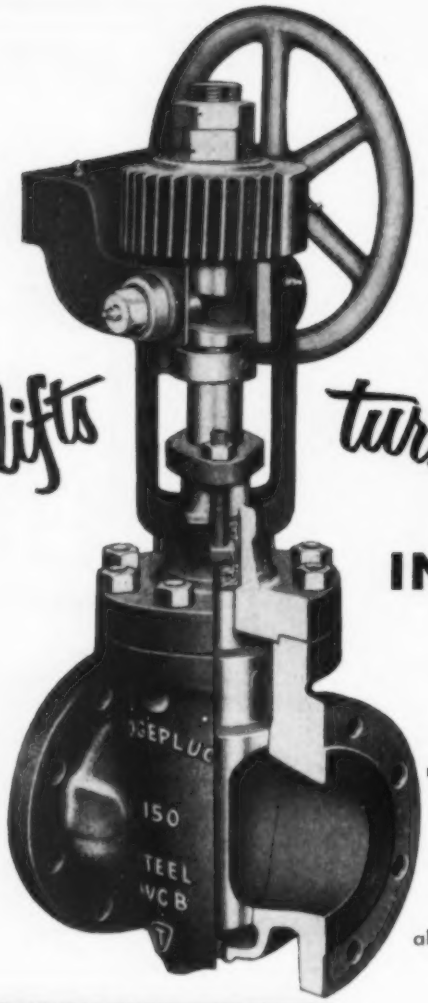
| Reference | Use In: | CONSUMPTION, Millions of Pounds | | | RATIO | | |
|---|---|---|---|---|---|---|---|
| | | 1950 | 1955 | 1975 | 1955–1950 | 1975–1950 | 1975–1955 |
| 84 | Alkyd Resins | 120 | 200 | 1200 | 1.7 | 10.0 | 6.0 |
| 85 | Phthalate Esters | 83 | 138 | 830 | 1.7 | 10.0 | 6.0 |
| 86 | Dystuffs | 15 | 25 | 65 | 1.7 | 4.3 | 2.6 |
| 87 | Food & Drugs | 7 | 12 | 32 | 1.7 | 4.6 | 2.7 |
| 88 | Others | 15 | 25 | 65 | 1.7 | 4.3 | 2.6 |
| 89 | | 240 | 400 | 2192 | 1.7 | 9.1 | 5.5 |

tion to make firm predictions of future needs and describes its figures as 'indicators of the size of the problems the United States is likely to face.'

"It seems a fair question whether the figures can be accepted even as 'indicators.' To raise this question is not to disparage the efforts of the commission, which has made perhaps as intelligent a set of guesses as can be made at present. A quarter of a century, however, can bring sweeping and unpredictable changes in relative costs, new discoveries and inventions, and shifting channels of consumer demand, to say nothing of wars and depressions. The commission itself touches on some of these possible changes when it refers to wasteful methods of extraction and utilization of resources and to the fact that only 11 percent of the country's surface area is adequately mapped geologically and that perhaps half of the subsurface area 'is covered with a mantle of young rocks, which may conceal vast riches.'

"In the face of such uncertainties, even the most careful quarter-century projections of past trends would seem unreliable."

The comparable figures for 1950, 1955, and 1975 are presented in the accompanying tables. Also see pages 97 and 100. These tables also include ratios of the yearly figures. These collated data are reprinted from a private bulletin of R. S. Aries & Associates, New York.



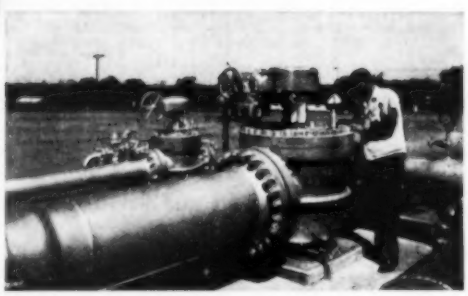

lifts turns and reseats

IN ONE OPERATION

The Wedgeplug Principle—which is the application of power through a simple, patented cam mechanism—assures a quick, positive lift of the tapered, *non-lubricated* Plug from its protected, raised seating surfaces; a 90-degree turn; and, then, a lowering and tight re-seating of the Plug—all accomplished in sequence, and by a few turns of the handwheel. Trouble-free action, regardless of temperature or pressure.

**WEDGEPLUG**
General Service
**STEEL VALVES**

Large port openings assure minimum pressure drop. Compact; easy to adjust while in service. Available in three types: Wrench-operated, Handwheel-operated, Worm-Gear-operated. All sizes can be steam-jacketed. Adaptable for remote control.



**WRITE FOR CATALOG NO. 52-12-W**

**WEDGEPLUG VALVE COMPANY, INC.**

**1304 BROAD AVENUE, NEW ORLEANS 15, LA.**

***An Affiliate of* STOCKHAM VALVES & FITTINGS, *Birmingham, Ala.***

*Efficient warehousing means refinery equipment is always immediately available.*

*Palletized drums being loaded by E-P fork truck.*

# How.. Refineries SAVE with ELWELL-PARKER Trucks

Elwell-Parkers achieve *mass movement* of hundreds of refinery items—*on schedule, with safety to employees and at BIG Savings in storage space and labor.*

For the *continuous* operations necessary in refineries, E-P trucks are ideal because of their built-in dependability. 15 to 20 years of steady service is frequent. Their design simplifies preventative maintenance that eliminates costly bottlenecks due to truck failures.

Elwell-Parker gives *unbiased* advice on your truck needs—for Elwell-Parker builds *ALL* basic types, in over 80 different models, gas or electric powered.

Take advantage of Elwell-Parker's 47 years' experience by calling in the nearest of the E-P Field Application Engineers.

### FACTS ON TRUCKS

Get the full story on each type by writing for this General Catalog. The Elwell-Parker Electric Co., 4265 St. Clair Ave., Cleveland 3, Ohio.

**ELWELL-PARKER**

**POWER INDUSTRIAL TRUCKS**

*Established 1893*

*Always added to these*

# ervice ..*plus*+

Wherever oil and gas are found, Dresser Industries' equipment is well-known. Wherever the business is oil, "let's deal with a Dresser Company" finds ready acceptance.

Dresser Industries has become a driving force in the advancement of the oil industry through the development, manufacture and distribution of superior equipment. Behind this equipment stands another Dresser distinction: *Service Plus.*

Through its member companies . . . each a recognized leader in its field . . . Dresser offers its customers the personalized, specialized experience of a small concern. Offers them this and more. Each member company can draw upon the pooled resources of engineering know-how and research facilities of the entire Dresser Industries organization . . . thus giving even greater service at no extra cost.

That's why you get more when you do business with Dresser. That's why Dresser goes to such great lengths to give you *Service Plus!*

*Operating Units*

**BOVAIRD & SEYFANG MANUFACTURING COMPANY**
*Bradford, Pa. — Founded 1891*

**CLARK BROS. CO. DIVISION, DRESSER OPERATIONS, INC.**
*Olean, N. Y. — Founded 1880*

**DRESSER MANUFACTURING DIVISION**
*Bradford, Pa. — Founded 1880*

**IDECO DIVISION, DRESSER EQUIPMENT COMPANY**
*Dallas and Beaumont, Texas — Founded 1920*

**IDECO DIVISION, DRESSER-STACEY COMPANY**
*Columbus, Ohio — Founded 1920*

**KOBE, INC. DIVISION, DRESSER EQUIPMENT COMPANY**
*Huntington Park, Calif. — Founded 1923*

**MAGNET COVE BARIUM CORPORATION**
*Houston, Texas; Malvern, Arkansas — Founded 1940*

**PACIFIC PUMPS, INC.**
*Huntington Park, Calif. — Founded 1923*

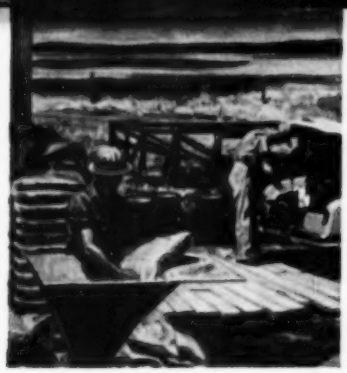
**ROOTS-CONNERSVILLE BLOWER DIVISION**
*Connersville, Ind. — Founded 1854*

**SECURITY ENGINEERING DIVISION, DRESSER OPERATIONS, INC.**
*Whittier, Calif.; Dallas, Texas — Founded 1931*

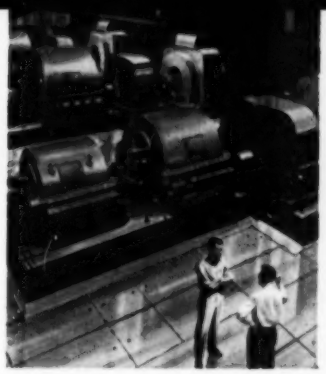
**STACEY BROTHERS DIVISION, DRESSER-STACEY COMPANY**
*Cincinnati, Ohio — Founded 1915*

**DRESSER INDUSTRIES, INC.**
OIL, GAS AND CHEMICAL EQUIPMENT

ATLANTIC BUILDING DALLAS, TEXAS



**Magnet Cove Barium Corp.,** ***Houston, Tex., Malvern, Ark., Greybull, Wyo.*** Magcobar drilling mud, Magcogel bentonite, Mylojel, Fiber Seal, Jel-Oil mud.

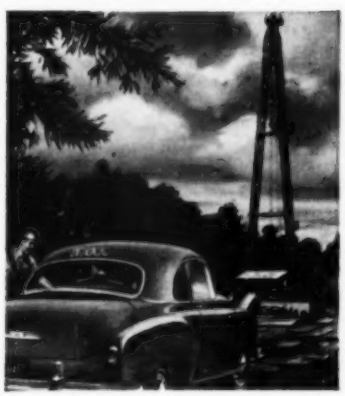


**Roots-Connersville Blower Division,** ***Connersville, Ind.*** Rotary positive blowers, gas pumps; centrifugal blowers, exhausters; positive displacement meters.

## *Companies' services to the Oil Industry is the Dresser plus* +

**Security Engineering Division,** ***Whittier, Calif., Dallas, Tex.*** Rock bits, reamers, casing scrapers, reamer rock bits, coring bits, Securaloy.

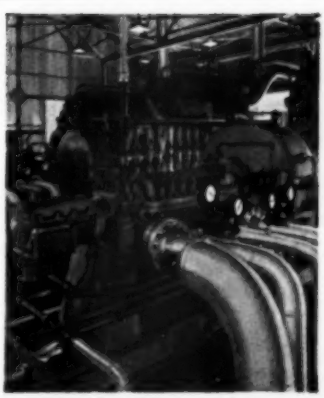
**Clark Bros. Co. Division,** ***Olean, New York.*** Engines and compressors — gas, steam and diesel driven.



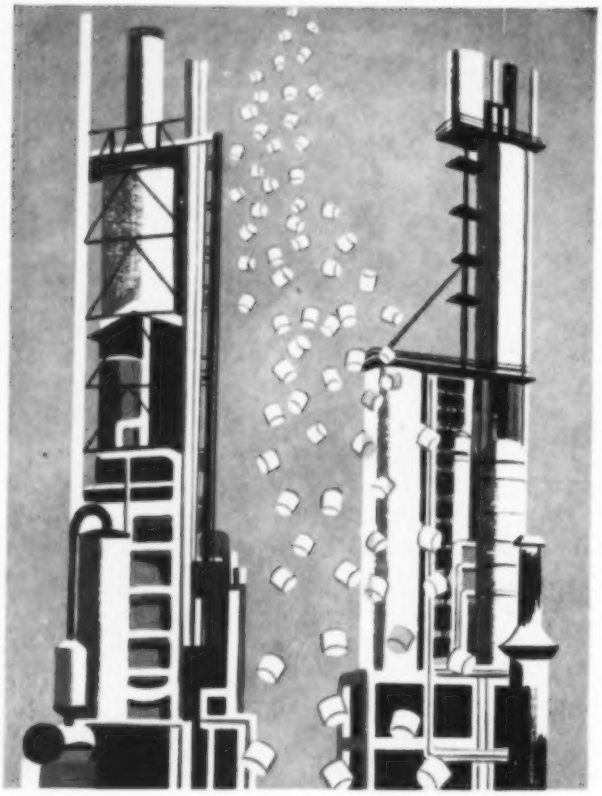
**Ideco Division,** ***Dallas, Beaumont, Tex., Torrance, Calif.*** Derricks, drawworks, rambler drilling rigs, traveling blocks, rotary tables.

**Kobe, Inc., Division,** ***Huntington Park, Calif.*** Complete hydraulic oil field pumping systems, including the Kobe Free Pump.

**Pacific Pumps, Inc.,** ***Huntington Park, Calif.*** Centrifugal pumps, deep oilwell plunger pumps, hot oil and boiler feed pumps.



**Dresser Manufacturing Division,** ***Bradford, Pa.*** Oil and gas and pipe couplings, fittings and sleeves — rolled and welded rings — welding fittings and flanges.



# Filtrol SR Pelleted Cracking Catalyst

FOR HOUDRIFLOW AND AIR-LIFT TCC UNITS. FILTROL SR CATALYST IS NOW BEING USED SUCCESSFULLY IN COMMERCIAL OPERATION. SR CATALYST YIELDS HIGH OCTANE CATALYTIC GASOLINE AND CAN BE USED PROFITABLY IN CRACKING A FULL RANGE OF GAS OILS, INCLUDING HIGH SULFUR BEARING STOCKS. SHOWN BELOW ARE THE CHARACTERISTICS OF SR CATALYST AS COMPARED TO REGULAR FILTROL TCC PELLETED CATALYST USED SO SUCCESSFULLY SINCE 1943:

| GRADE | FILTROL TCC (23) | FILTROL SR (63) |
|---|---|---|
| ACTIVITY BY CAT A | 40 | 36 |
| CPF | 1.0 | 1.0 |
| PELLET DIAMETER | 0.19" | 0.19" |
| MESH 3-6 MESH | 99% | 98.5% |
| HARDNESS | 70 | 93 MIN. |

TYPICAL YIELDS OF SR AS COMPARED TO REGULAR FILTROL TCC ARE:

| GRADE | FILTROL TCC (23) | FILTROL SR (63) |
|---|---|---|
| CYCLE OIL, VOL. % | 48 | 48 |
| DEBUT. GASO., VOL. % | 42 | 40.5 |
| DRY GAS, WT. % | 5.0 | 5.8 |
| TOTAL $C_4$, VOL. % | 12 | 13.5 |
| COKE, WT. % | 4.8 | 3.9 |
| OCT. NO. F-1 CLR. | 90 | 92.5 |

OTHER
REASONS FOR USING
FILTROL CATALYSTS

1. Higher Octane Barrels
2. High Butylene Yield
3. Low Cost
4. Varied Plant Facilities
5. Faster Regeneration Rate
6. Low Attrition Rate
7. Technical Service
8. Uniformity
9. Lowered Excess Butane

Filtrol*

*T. M. REG. U. S. PAT. OFF.

FILTROL CORPORATION

OFFICES: 727 WEST SEVENTH STREET, LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

CATALYSTS AND ADSORBENTS

# Chemicals will look this way . . .

(See text starting on page 93)

**TABLE 8**
**Estimated Use of Styrene**

| Reference | Use In: | CONSUMPTION, Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| 90 | Polystyrene | 262 | 350 | 715 | 1.3 | 2.7 |
| 91 | Styrene Copolymers | 93 | 270 | 1420 | 2.9 | 15.2 |
| 92 | Total Styrene Resins | 355 | 620 | 2135 | 1.7 | 6.0 |
| 93 | GRS Rubber | 175 | 380 | 1800 | 2.2 | 10.3 |
| 94 | Sub-Total | 530 | 1000 | 3935 | 1.9 | 7.4 |
| 95 | Others | 10 | N.A. | N.A. | | |
| 96 | TOTAL | 540 | N.A. | N.A. | | |

**TABLE 9**
**Production of Cyclic End Products**

| Reference | | PRODUCTION, Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| 97 | Plastics (Benzenoid) | 1284 | 2690 | 12800 | 2.1 | 10.0 |
| 98 | Synthetic Rubber (GRS) | 802 | 1900 | 9000 | 2.4 | 11.2 |
| 99 | Insecticides | 175 | 325 | 2100 | 1.9 | 12.0 |
| 100 | Surfactants | 383 | 936 | 1865* | 2.4 | 4.9 |
| 101 | Plasticizers | 181 | 300 | 1800 | 1.7 | 10.0 |
| 102 | Solvents | 679 | 787 | 1244 | 1.2 | 1.8 |
| 103 | Dyes | 196 | 232 | 352 | 1.2 | 1.8 |
| 104 | Color Lakes & Toners | 37 | 65 | 133 | 1.8 | 3.6 |
| 105 | Medicinals | 41 | 45 | 69 | 1.1 | 1.7 |
| 106 | Rubber Chemicals | 98 | 117 | 450 | 1.2 | 4.6 |
| 107 | Flavors and Perfumes | 19 | 22 | 36 | 1.2 | 1.9 |
| 107A | | 3895 | 7419 | 29849 | 1.9 | 7.7 |
| | * Another Forecast for both Cyclic and Acyclic Surfactants: | | | | | |
| 108 | Net Surfactant Content | 676 | 800 | 1600 | 1.2 | 2.4 |
| 109 | Gross Detergent | 1660 | 2000 | 4000 | 1.2 | 2.4 |

**TABLE 10**
**Production of Crude Products From Petrochemical and Competitive Sources**

| Reference | | PRODUCTION, Million of Pounds* 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| 110 | Naphthenic Acids, Total | 25 | 35 | 75 | 1.4 | 3.0 |
| | **Aliphatic Hydrocarbons** | | | | | |
| 111 | Ethylene, Probable | 1536 | 3295–3345 | 8497–9697 | 2.1–2.2 | 5.5–6.3 |
| 112 | Minimum not Replaceable by Acetylene and Assuming 40% of Ethanol from other Sources | | 2550 | 7000 | | |
| 113 | Additional if Acetylene not Used and Allethyl Alcohol made from Ethylene Butylene | | 1000 | 3400 | | |
| 114 | Normal | 641 | 1940 | N A | 3.0 | |
| 115 | ISO | N A | 242 | N A | | |
| 116 | TOTAL | N A | 2182 | 4700 | | |
| | **Propylene** | | | | | |
| 117 | For Surfactants | N A | 317 | 726 | | |
| 118 | For Plastics | N A | 129 | 292 | | |
| 119 | For Other Uses | N A | 1115 | 2545 | | |
| 120 | TOTAL | 694 | 1561 | 3563 | 2.2 | 5.1 |
| 121 | **Pentanes** | N A | 35 | 75 | | |
| | **Hepta and Higher Olefins** | | | | | |
| 122 | Normal Heptene for Octyl Phthalate Plasticizer | N A | 70 | 180 | | |
| 123 | Others | N A | 30 | 200 | | |
| 124 | TOTAL | N A | 100 | 380 | | |
| 125 | Total Aliphatic Hydrocarbons Listed above | 3314 | 7173–7223 | 17215–18415 | 2.2 | 5.2–5.6 |

* Benzene, Toluene, and Xylene Included with Tar Crudes

**TABLE 11**
**Estimated Use of Ethylene**

| Reference | Use In: | CONSUMPTION, Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| | **Products of Ethylene Oxide** | | | | | |
| 126 | Ethylene Glycol | 338 | 457 | 737 | 1.4 | 2.2 |
| 127 | Glycol Ethers | 54 | 61 | 87 | 1.1 | 1.6 |
| 128 | Ethanolamines | 28 | 42 | 97 | 1.5 | 3.5 |
| 129 | Acrylonitrile | 24 | 150–200 | 1200–2400 | 6.3–8.3 | 50.0–100.0 |
| 130 | Detergents | 19 | 46 | 123 | 1.2 | 3.2 |
| 131 | Others | 20 | | | | |
| 132 | Total in Products of Ethylene Oxide | 483 | 756–806 | 2244–3444 | 1.6–1.7 | 4.6–7.1 |
| 133 | Ethyl Alcohol | 495 | 1375 | 3378 | 2.8 | 6.8 |
| 134 | Ethyl Benzene | 173 | 500 | 760 | 2.9 | 4.4 |
| 135 | Ethyl Chloride | 137 | 230 | 575 | 1.7 | 4.2 |
| 136 | Ethylene Dichloride | 90 | 81 | 195 | 0.9 | 2.2 |
| 137 | Ethylene Dibromide | 30 | 38 | 70 | 1.3 | 2.3 |
| 138 | Polyethylene | 55 | 200 | 1000 | 3.6 | 18.0 |
| 139 | Others | 73 | 115 | 275 | 1.6 | 3.8 |
| 140 | | 1536 | 3295–3345 | 8497–9697 | 2.1– | 5.5– |
| 141 | Agriculture (Included above in Others) | N A | 25 | 44 | | |

**TABLE 12**
**Production and Consumption of Acetylene for Chemical Use Only**
**(Millions of Pounds)**

| Reference | | Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| | **Production** | | | | | |
| 142 | From Calcium Carbide | 300 | 425 | 1000 | 1.4 | 3.3 |
| 143 | From Petrochemical Sources | | 125–1055 | 2000–5750 | | |
| 144 | TOTAL | 300 | 550–1480 | 3000–6750 | 1.8–4.9 | 10.0–22.5 |
| | **Maximum Consumption** | | | | | |
| 145 | For Chemicals Derivable from Acetylene Only | N.A. | 1050 | 4760 | | |
| 146 | For Chemicals also Derivable from Ethylene | N.A. | 430 | 1990 | | |
| 147 | | N.A. | 1480 | 6750 | | |
| 148 | Plastics | | 348 | 1024 | | |
| 149 | Synthetic Fibers (Except Rayon) | | 160 | 1104 | | |
| 150 | Other Chemicals more likely to be Derived from Ethylene | | 113 | 708 | | |
| 151 | Others | | 859 | 3914 | | |
| 152 | | | 1480 | 6750 | | |

**TABLE 13**
**Estimated Use of Methane**

| Reference | Use In: | CONSUMPTION, Millions of Pounds 1955 | 1975 |
|---|---|---|---|
| | **Acetylene Derivatives and Other Chemicals** | | |
| 153 | Urea-Melamine Plastics Excluding Ammonia Requirement | 135 | 299 |
| 154 | Phenolic Resins | 175 | 328 |
| 155 | Other Plastics | 30 | 75 |
| 156 | Rayon | 106 | 187 |
| 157 | Other Synthetic Fibers | 70 | 373 |
| 158 | Methyl Chloride | 19 | 42 |
| 159 | Methylene Dichloride | 14 | 28 |
| 160 | Chemicals Derivable from Ethylene | 400 | 1800 |
| 161 | Others | 1451 | 5268 |
| 162 | Sub-Total | 2400 | 8400 |
| 163 | Ammonia | 4800 | 9500 |
| 164 | Carbon Black | 24800 | 13000 |
| 165 | TOTAL METHANE | 32000 | 30900 |

# Where can YOU use these unusual

Since their introduction less than two years ago, Masoneilan 60000 Series Controllers have won wide acceptance through superior performance, great versatility, and simplicity of adjustment and operation. We believe that you, too, will like these "Instrument Man's Instruments" once you have seen them.

The Proportional-Reset Controller
Note that all settings are accessible without removing chart.

A HIGH Cq (Quality Coefficient) PRODUCT

# Pneumatic Controller Advantages?

## Consider versatility for example. In *one* instrument you can obtain *all* these...

**ON-OFF CONTROL**
simply by setting the Proportional Band Wheel to minimum proportional band — like ← this. Action may be either direct or reverse.

**DIFFERENTIAL GAP CONTROL**
by turning the Proportional Band Wheel to the "Gap" quadrants, either direct action like ← this or reverse action like this →

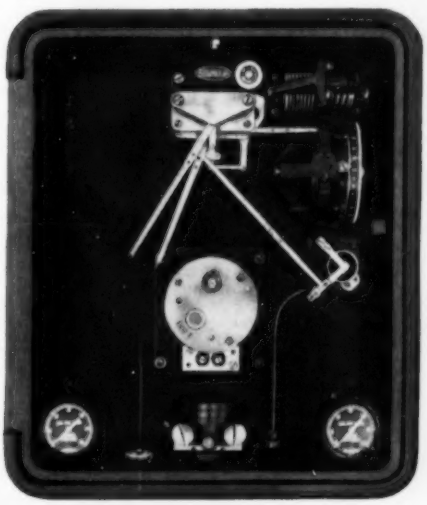
**PROPORTIONAL CONTROL**
by setting the Proportional Band Wheel to the required proportional band in the direct action quadrant like ← this or the reverse action quadrant like this →

Reset Unit

Proportional Unit

**PROPORTIONAL-RESET CONTROL**
by substituting the Reset Unit for the Proportional Unit. No piping changes — you simply plug in the unit, realign (one adjustment), turn Proportional Band Wheel to desired direct or reverse action quadrant, and set required reset rate.

Or if versatility is not important to you, consider these advantages to the Instrument Man—



**PILOT** — of amplifying, balanced type is easily serviced because of its simple construction and cleanable orifice.

**MANIFOLDED AIR PASSAGES** — with plug-in connections, eliminate pressure fittings and clutter of tubing; facilitate interchangeability of individual subassemblies and accessibility of adjustments.

**NOZZLE** — is *easily* removed, cleaned, replaced and calibrated.

**MINIMUM OF ADJUSTMENTS** — with large knobs or wheels provided for making them; plus easily read scales to aid in settings.

**SIMPLICITY** — of unit subassemblies, and of their arrangement, for ease of adjustment and servicing.

If you have not already seen these controllers we suggest you arrange for a demonstration in your own office or plant. Simply write or telephone our office nearest you. It will help to solve *your* control problem.

**MASON-NEILAN**
**REGULATOR COMPANY**
**1182 ADAMS STREET, BOSTON 24, MASS., U. S. A.**

*Sales Offices or Distributors in the Following Cities:* New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia • Houston
Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco • Boise • Louisville • Salt Lake City • El Paso • Albuquerque
Charlotte • Los Angeles • Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Dallas • Seattle
Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

# By 1975 . . .

(See text starting on page 93)

**TABLE 14**
**Production of Medicinals**

| Reference | | PRODUCTION, Millions of Pounds 1950 | 1975 | RATIO |
|---|---|---|---|---|
| | **Total** | | | |
| 166 | Grand Total | 49.3 | 61.3 | |
| 167 | Cyclic* | 41.4 | 52.1 | |
| 168 | Acyclic | 7.9 | 9.2 | |
| | **Cyclic** | | | |
| 169 | Total | 41.4 | 52.1 | |
| 170 | Benzenoid | 32.3 | 42.2 | |
| 171 | Alicyclic and Heterocyclic | 9.1 | 9.9 | |
| | **Benzenoid** | | | |
| 172 | Total | 32.3 | 42.2 | |
| 173 | Acetylsalicylic Acid (Aspirin) | 11.1 | 14.0 | |
| 174 | Salicylic Acid, Medicinal Grade Only | 5.6 | 7.9 | |
| 175 | Sulfa Drug, Total | 5.0 | 6.1 | |
| 176 | Others | 10.6 | 14.2 | |
| | **Alicyclic and Heterocyclic** | | | |
| 177 | Total | 9.1 | 9.9 | |
| 178 | Barbituric Acid Derivatives, Total | 0.7 | 1.0 | |
| 179 | Caffeine, Natural and Synthetic and Derivatives | 1.7 | 1.6 | |
| 180 | Vitamins, Total | 2.0 | 2.2 | |
| 181 | Others | 4.7 | 5.1 | |
| | **Acyclic** | | | |
| 182 | Total | 7.9 | 9.2 | |
| 183 | Vitamins, Total | 1.5 | 1.9 | |
| 184 | Others | 6.4 | 7.3 | |
| 185 | * Total Cyclic, Second Forecast | 49 | 69 | |

(1955 Figure for this Second Forecast —45. Ratio 1955–1950 = 1.1; 1975–1955 = 1.5)

**TABLE 15**
**Production of Plastics and Resin Materials**

| Reference | | PRODUCTION, Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| 186 | Grand Total (Non-Cellulosic) | 2150 | 4075 | 16920 | 1.9 | 7.9 |
| | **Benzenoid** | | | | | |
| 187 | Phthalic Alkyd | 333 | 560 | 1330–3330 | 1.7 | 4.0–10.0 |
| 188 | Phenolics | 451 | 850–930 | 4510 | 1.9–2.1 | 10.0 |
| 189 | Polystyrene | 261 | 350 | 715 | 1.3 | 2.7 |
| 190 | Styrene Copolymers | 94 | 540 | 2835 | 5.7 | 30.0 |
| 191 | Others | 145 | 310–380 | 3410–5410 | 2.1–2.6 | 2.4–3.7 |
| 192 | Total Benzenoid | 1284 | 2690 | 12800 | 2.1 | 10.0 |
| | **Non-Benzenoid** | | | | | |
| 193 | Urea and Melamine Resins | 219 | 265 | 570 | 1.2 | 2.6 |
| 194 | Vinyl Resins | 381 | 700 | 2000 | 1.8 | 5.3 |
| 195 | Polyethylene | 55 | 200 | 1000 | 3.6 | 18.2 |
| 196 | Others | 211 | 220 | 550 | 1.0 | 2.6 |
| 197 | Total Non-Benzenoid | 866 | 1385 | 34120 | 1.6 | 4.8 |
| 198 | Cellulosics | 130 | 135 | 175 | 1.0 | 1.3 |

**TABLE 16**
**Production of Synthetic Fibers**

| Reference | | PRODUCTION, Millions of Pounds 1950 | 1975 | RATIO |
|---|---|---|---|---|
| 199 | Nylon and Polyamides | 100 | 800 | |
| 200 | Acrylic Based (Orlon, Acrilan, Dynel, Etc.) | 12 | 1200 | |
| 201 | Polyesters (Dacron, Etc.) | 0 | 1000 | |
| 202 | Others | 45 | 1000 | |
| 203 | Sub-Total | 157 | 4000 | |
| 204 | Rayon | 1350 | 3000 | |
| 205 | TOTAL | 1507 | 7000 | |

**TABLE 17**
**Production of Other Groups**

| Reference | | PRODUCTION, Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| 206 | Elastomers* | 1166 | N.A. | 4480 | ... | 3.8 |
| | **Plasticizers** | | | | | |
| 207 | Phthalic Ester Type | 142 | 210 | 540 | 1.5 | 3.8 |
| 208 | Others | 101 | 140 | 360 | 1.4 | 3.6 |
| 209 | TOTAL | 243 | 350 | 900 | 1.4 | 3.7 |
| 210 | Surface Active Agents | 676 | 800 | 1600 | 1.2 | 2.4 |

* See another forecast for GRS and Surfactants under Cyclic End Products.

**TABLE 18**
**Production of Miscellaneous Chemicals**

| Reference | | PRODUCTION, Millions of Pounds 1950 | 1955 | 1975 | RATIO 1955–1950 | 1975–1950 |
|---|---|---|---|---|---|---|
| | **Insecticides** | | | | | |
| 211 | DDT | 78 | 125 | 200 | 1.6 | 2.6 |
| 212 | BHC | 77 | 170 | 225 | 2.2 | 2.9 |
| 213 | 2,4D and Derivatives | 26 | 40 | 80 | 1.5 | 3.1 |
| | **Formaldehyde (100% Basis)** | | | | | |
| 214 | For Urea-Melamine Plastics | N.A. | 169 | 363 | ... | ... |
| 215 | For Phenolic Plastics | N.A. | 265 | 495 | ... | ... |
| 216 | For Other Uses | N.A. | 241 | 432 | ... | ... |
| 217 | TOTAL | 308 | 675 | 1290 | 2.2 | 4.2 |
| 218 | Methyl Chloride | 27 | 55 | 120 | 2.0 | 4.4 |
| 219 | Methylene Chloride | 40 | 60 | 120 | 1.5 | 3.0 |
| | **Methanol, Synthetic** | | | | | |
| 220 | From Natural Gas | 546 | 1080 | 0 | 2.0 | |
| 221 | From Coke | 356 | 396 | 760–1160 | 1.1 | 2.1–3.3 |
| 222 | From Direct Coal Gasification | 0 | 112 | 5000–4600 | ... | ... |
| 223 | TOTAL | 902 | 1588 | 5760 | 1.8 | 6.4 |
| 224 | Used for Formaldehyde | 332 | 658 | 3630 | 2.0 | 1.1 |
| 225 | Used for Other Purposes | 570 | 930 | 2130 | 1.6 | 3.7 |

## INDEX OF CHEMICALS


| CHEMICAL | REFERENCE |
|---|---|
| Acetylene | 142-152 |
| Acetysalicylic Acid | 173 |
| Acrylonitrile | 129 |
| Agricultural Chemicals | 141 |
| Alkyd Resins | 84 |
| Ammonia | 163 |
| Aniline | 27 |
| Baroituric Acid Der. | 178 |
| Benzene | 1-4, 25-42 |
| Benzene Hexachloride | 38, 40, 212 |
| Benzol, Motor | 5-6 |
| Butylene | 113-116 |
| Caffeine | 179 |
| Carbon Black | 164 |
| Chemicals, Cyclic | 107 A |
| Color Lakes & Toners | 104 |
| Cresols | 52-54, 68-77 |
| Cresylic Acid | 55-57, 68-77 |
| 2,4,D | 40, 213 |
| DDT | 29,40, 211 |
| Dichlorobenzene | 33 |
| Diphenyl Der. | 30 |
| Disinfectants | 71 |
| Dyestuffs | 46, 86, 103 |
| Elastomers | 206 |
| Ethanolamines | 128 |
| Ethyl Alcohol | 133 |
| Ethylbenzene | 134 |
| Ethyl Chloride | 135 |
| Ethylene | 111-113, 126-141 |
| Ethylene Dibromide | 137 |
| Ethylene Dichloride | 136 |
| Ethylene Glycol | 126 |
| Ethylene Oxide | 126-132 |
| Flavors and Perfumes | 107 |
| Food and Drug Chemicals | 87 |
| Formaldehyde | 214-217, 224 |
| Glycol | 127 |
| Insecticides | 29, 38, 40, 99, 211-213 |
| Lubricating Oil Addit. | 74 |
| Lubricating Oil Ref. Chem. | 73 |
| Maleic Anhydride | 31 |
| Medicinals | 105, 166-185 |
| Methane | 153-165 |
| Methanol | 220-225 |
| Methyl Chloride | 158, 218 |
| Methylene Chloride | 219 |
| Methylene Dichloride | 159 |
| Monochlorobenzene | 34 |
| Moth Repellents | 47 |
| Motor Benzol | 5-6 |
| Naphtha | 18-20 |
| Naphthalene | 21-24, 43-51, 58 |
| Naphthenic Acids | 110-125 |
| Nitrobenzene | 35 |
| Nylon | 28, 199 |
| Olefins | 111-125 |
| Ore Flotation Chem. | 70 |
| Pentanes | 121 |
| Phenol | 25, 59-62, 78-83 |
| Phenolic Resins | 39, 68, 78, 154, 188, 215 |
| Phthalate Esters | 85 |
| Phthalic Alkyd Resins | 187 |
| Phthalic Anhydride | 43,63, 84-89 |
| Picolines | 64 |
| Plasticizers | 69, 101, 207-209 |
| Plastics | 26, 39, 68, 78, 84, 90-97, 118, 138, 148, 153-155, 186-198, 214-215 |
| Polyethylene | 138, 195 |
| Polystyrene | 90, 189 |
| Propylene | 117-120 |
| Pyridene | 65 |
| Quinoline | 66 |
| Rayon | 204 |
| Rubber Chemicals | 106 |
| Salicylic Acid | 174 |
| Solvent Refining Chem. | 80 |
| Solvents, Cyclic | 102 |
| Styrene | 26, 67, 90-96 189-190 |
| Surfactants | 32, 48, 100, 108-9 117, 210 |
| Sulfa Drugs | 175 |
| Synthetic Detergents | 32, 109 |
| Synthetic Fibers | 41, 129, 149, 199-205 |
| Synthetic Rubber | 42, 93, 98, 206 |
| Toluene | 7-10 |
| Tricresyl Phosphate | 69 |
| Urea-Melamine Resins | 153-214 |
| Vitamins | 180, 183 |
| Xylenes | 11-17 |

# How Layne assures your water supply

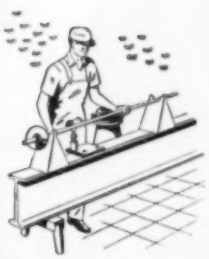
## UNDIVIDED LAYNE RESPONSIBILITY MEANS COMPLETE SERVICE, LOWER COSTS

### Layne surveys and test wells

Layne's *complete* service begins long before the wells are drilled . . . with geological surveys made in cooperation with engineers of the client company or municipality. Test-hole drilling shows actual conditions.

### Layne analyses and recommendations

Samples taken from the test holes go to Layne's central laboratories, where technicians report on the earth structure and qualities of the water. From these reports, water-system recommendations are made.

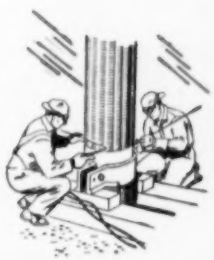


### Layne-engineered pumps, screens, casings

Into every Layne well goes equipment designed for the specific job—the finest equipment, produced with the greatest economy, because of Layne's thorough engineering skill and world-wide experience.

### Layne installation and maintenance service

Skilled Layne workmen handle every stage of the job—assuring a system custom-engineered for your own situation. And Layne's experience is always at your service for any maintenance work you may need.



## Let Layne help you plan ahead on your water needs

Layne welcomes the opportunity to share in long-range planning for your water-supply needs. For information on any phase of well water supply or pump equipment, contact your nearest Layne Associate Company or write Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

**WATER WELLS • VERTICAL TURBINE PUMPS**
**WATER TREATMENT**

*Layne Associate Companies Throughout the World*

ECONOMICAL answers to industrial problems—a few of which are shown on these pages—call for specialized *facilities* and years of *experience.*

Here at Alco you will find a large measure of both. You will find experience gained through many years of designing and fabricating heavy metal equipment for petroleum, chemical, power and manufacturing companies all over the world.

You will find modern equipment and machines, many of them designed and built by Alco, capable of meeting almost every conceivable type of metal-fabricating requirement—facilities operated by skilled craftsmen, and applied by designers and engineers fully aware of industry's needs.

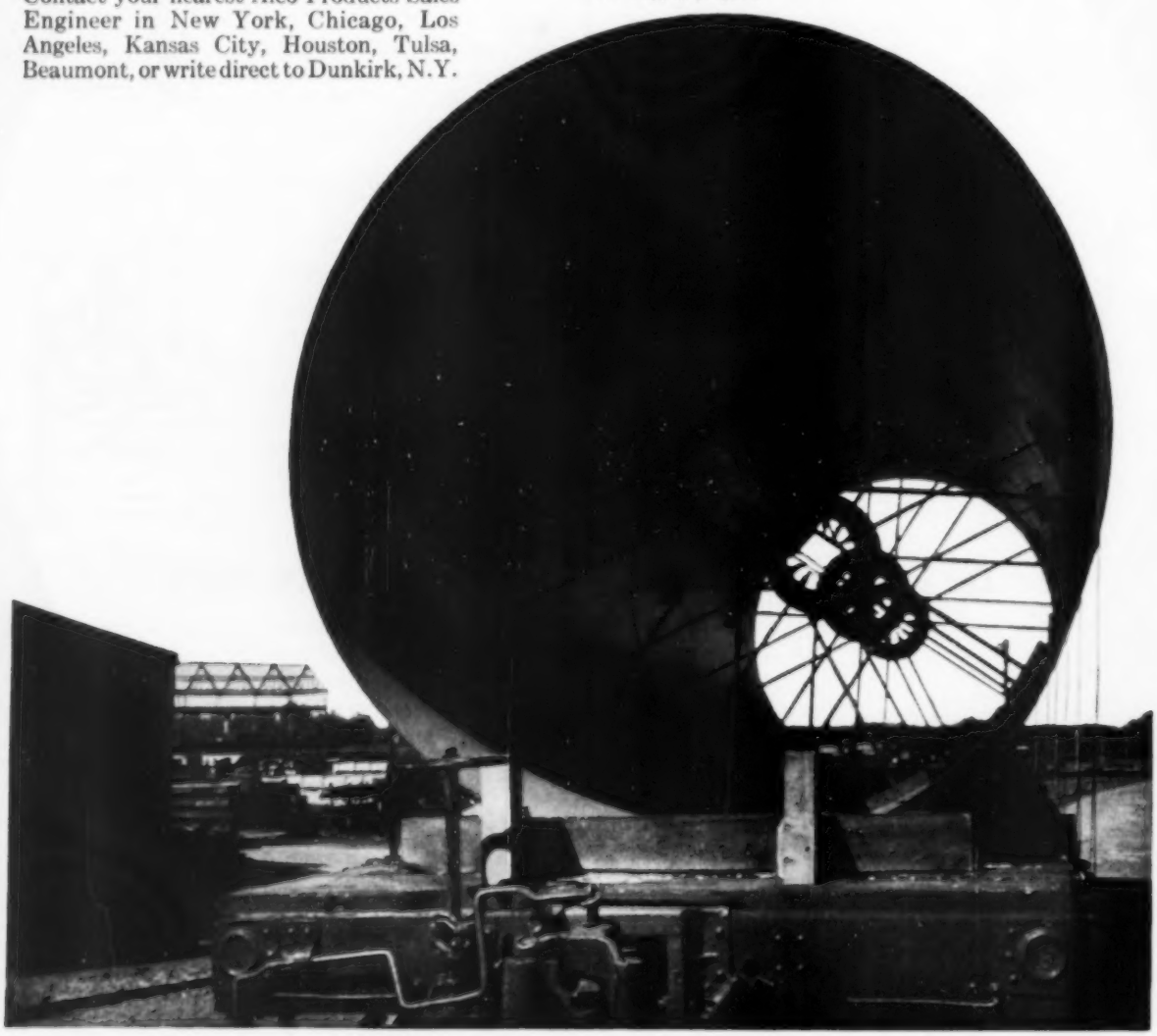
If you have a difficult metal-fabricating problem—a problem that challenges the imagination, that points to new equipment or offers new opportunities to cut production costs—we invite you to let Alco's facilities and experience produce the answer.

Contact your nearest Alco Products Sales Engineer in New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa, Beaumont, or write direct to Dunkirk, N.Y.

*ALCO facilities*

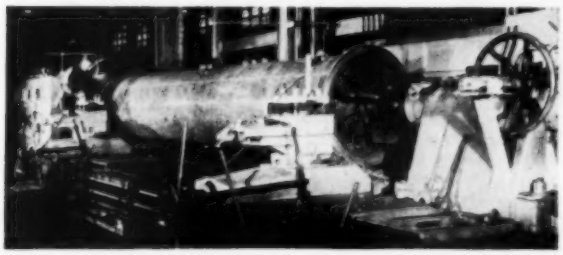
# Answers to

**TUNNEL INTERLININGS** furnished by Alco in cold-rolled, carbon-silicon steel sections 40 ft long and 10 ft 6 in. in diameter will reinforce the outlet end of New York City's new $44,000,000 deep-rock East Delaware Water Supply Tunnel. Held to close dimensional limits, electric fusion welded throughout, they are the latest of many special piping sections fabricated over the years by Alco for New York water supply projects.

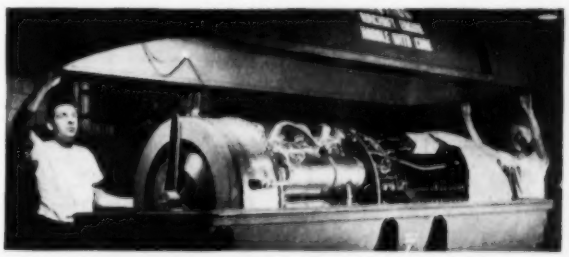


*and experience produce...*

# New Industrial Problems



**GIANT LATHE** at Alco's 31-acre Dunkirk plant finishes and faces both flanges simultaneously on steel pipe up to 41 in. in diameter! Special machines like this, many of them Alco designed and all guided by the skilled hands of veteran craftsmen, help Alco solve the toughest of metal-fabricating problems.

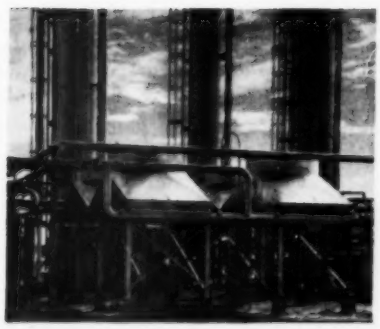


**STEEL "CANS" FOR JET ENGINES,** mass-produced by Alco, are carefully engineered to meet strict Air Force specifications. Example: they must "provide a barrier against the entry of water, dust, air and moisture *without* the aid of separately applied sealing compounds or materials."

**ALCO**

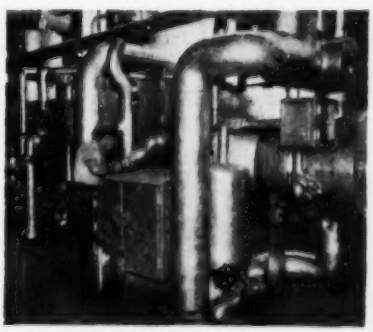
**ALCO PRODUCTS DIVISION**

**AMERICAN LOCOMOTIVE COMPANY • DUNKIRK, NEW YORK**

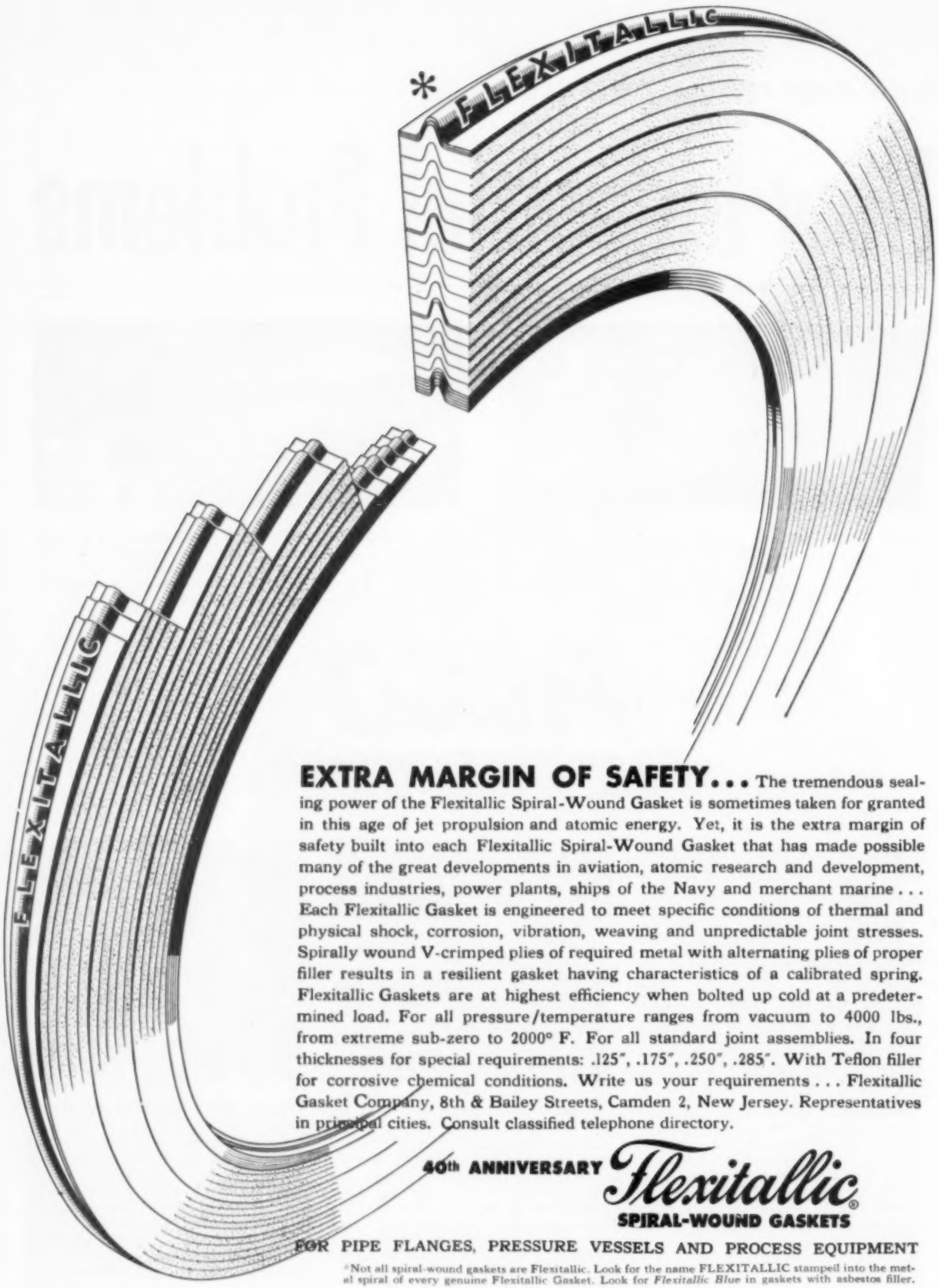


**"UNI-BUNDLE UNITS,"** with their specially fabricated steel headers, demonstrate the versatility of Alco Aircoolers. Vertical partitions welded in the headers allow several different vapor or liquid streams to be handled in a single tube-bundle. Here, for example, at a large Southwestern natural gasoline plant, the Alco Aircooler at right not only cools the oil but also condenses the overhead vapor from the stream.

**"TRAIN" HEAT EXCHANGERS,** designed and built of nickel steel by Alco for the Tennessee Gas Transmission Company's new gas processing plant (the world's largest) at Gabe, Kentucky, helped cut both installation and operating costs. Their flange-to-flange construction minimized the amount of connecting piping required, while their huge size (42 in. in diameter, 150 ft long) assured maximum processing efficiency.



**SPECIAL ALCO FLEX-TUBE EVAPORATORS** at the Carolina Power and Light Company's new 150,000-kw plant at Goldsboro, N. C., produce vapor containing not more than 0.5 parts per million of mineral solids, hold make-up to less than one-half of one per cent. With its patented Flex-Tube construction, this Alco evaporator offers industry a positive-acting thermo-mechanical descaling device for straight-tube installation.

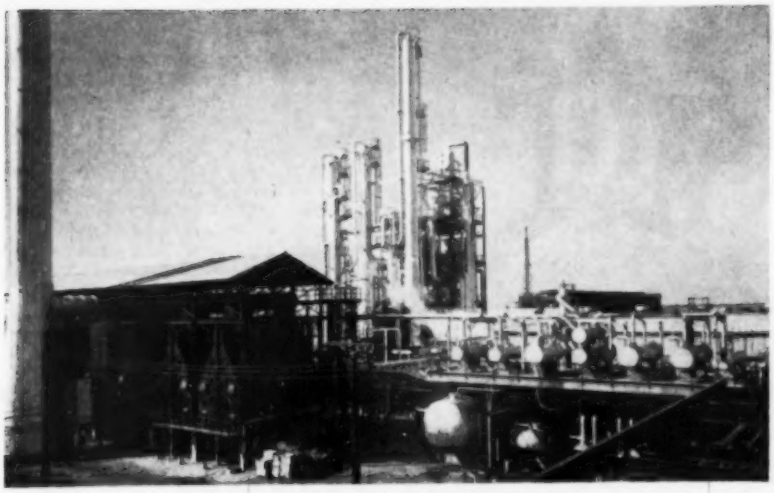



**EXTRA MARGIN OF SAFETY...** The tremendous sealing power of the Flexitallic Spiral-Wound Gasket is sometimes taken for granted in this age of jet propulsion and atomic energy. Yet, it is the extra margin of safety built into each Flexitallic Spiral-Wound Gasket that has made possible many of the great developments in aviation, atomic research and development, process industries, power plants, ships of the Navy and merchant marine . . . Each Flexitallic Gasket is engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally wound V-crimped plies of required metal with alternating plies of proper filler results in a resilient gasket having characteristics of a calibrated spring. Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 4000 lbs., from extreme sub-zero to 2000° F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". With Teflon filler for corrosive chemical conditions. Write us your requirements . . . Flexitallic Gasket Company, 8th & Bailey Streets, Camden 2, New Jersey. Representatives in principal cities. Consult classified telephone directory.

40th ANNIVERSARY *Flexitallic*®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* in gaskets with asbestos filler.



**Gulf May Double Capacity of Largest Ethylene Facilities—**

**The world's largest ethylene unit, recently placed in operation at Port Arthur, Texas, by Gulf Oil Corporation, will produce annually 2.5 billion cubic feet of ethylene gas. Five Texas coast installations have contracted for the unit's entire output and are now receiving the ethylene gas through direct connection pipe lines.**

**But even further expansion of the company's petrochemical facilities in the near future is being seriously considered. This project contemplates a second ethylene plant, which would double present production, as well as an ethylene oxide plant and an ethylene glycol plant. The company plans to offer only a portion of the capacity of the second plant for sale. The remainder would be used to produce 40 million pounds of ethylene oxide annually, which, in turn, would be converted into 5.5 million gallons of ethylene glycol.**

**The existing plant, like the design being considered for the future unit, comprises a series of fractionating towers for separating ethylene, ethane and other hydrocarbons from refinery gases; and a series of cracking furnaces for converting ethane to ethylene. The facilities are designed to be self sufficient and include a power plant for steam and electricity, a water cooling tower and circulating system, tanks, sewers, fire prevention apparatus and pipe lines.**

# [ Who's Building ]

## Amoniaco Starts Construction Of $13 Million Ammonia Plant

Construction has begun on a $13 million ammonia plant at Brea, Orange County, Calif., for lease to Brea Chemicals, Inc. The plant is being financed and built by Amoniaco Corporation on a 30-acre site two miles east of Brea.

The plant is expected to be opened in May, 1954. It will incorporate many new engineering features and use a special process to produce over 200 tons a day of ammonia for western agriculture and industry.

C. F. Braun & Company will construct the facility for Amoniaco. Brea Chemical, Inc., is a wholly owned subsidiary of Union Oil Company of California.

## New $7 Million Chemical Plant Now Being Built at Texas City

Texas City Chemicals, Inc., is presently constructing a new chemical plant at Texas City, Texas. The $7 million plant will be used to produce dicalcium phosphate, sulfuric acid and also for uranium recovery. Plans call for spent sulfuric acid obtained from nearby Carbide & Carbon Chemicals Company to be used in the production of dicalcium phosphate. Sulfuric acid will also be produced from elemental sulfur and sold to Carbide.

## Shell Chemical May Start Up Ventura Ammonia Plant Early

Progress in the construction of Shell Chemical Company's ammonia plant near Ventura, Calif., indicates that the plant, which will have a daily capacity of 150 tons of anhydrous ammonia, will probably be in operation before October, the expected completion date.

Process towers have been erected and compressor and steam-generating facilities are being installed. The M. W. Kellog Company is constructing the plant.

## Esso Standard Takes Options On Possible Refinery Site

Esso Standard Oil Company has taken options on about 950 acres of land in New York County, Va., as a possible refinery site. No final decision has been made to build a refinery there or any where else, the company said. However, Esso feels it must be prepared for the possibility that new capacity will be needed in the next few years.

The company now has options on two sites in Virginia. Last year it acquired options on 800 acres of land in West Norfolk. The latest options are on a parcel of land known as Goodwin Neck, on the York River.

## Large Argentinian Refinery Passes 75 Percent Completion

Seventy-five percent of the work has been done on the 28,300-barrel-a-day refinery being erected for Yacimientos Petroliferos Fiscales in the Argentine. The new plant is located at Eva Peron (formerly La Plata) and will be called the Presidente Peron refinery.

Constructed by YPF under the supervision of Kellogg Pan American Corporation, the refinery will include a Fluid catalytic cracking unit, alkylation and one of the world's largest delayed coking units. In addition, there will be two crude units, one of 21,000 barrel-a-day capacity and the other charging 7300 barrels a day. Other major processing equipment being erected comprises thermal cracking, straight-run gasoline fractionation, vacuum distillation and catalytic polymerization. The plant was designed by The M. W. Kellog Company, subsidiary of Pullman Incorporated.

## Modernized Esso Facilities To Start Operation Next June

Esso Standard Oil Company will place the new 18,500-barrel-a-day fluid catalytic cracking unit at its Everett, Mass., refinery in initial operation about June 1. At the same time other new facilities will go on stream, increasing the plant's crude capacity from 32,500 to 38,500 barrels a day.

Included in the modernization project were a fractionator, a gas-compression plant and light-ends recovery facilities. Foster Wheeler Corporation held the contract. Local forces built a 7000-barrel-a-day rerun unit.

The new fluid unit replaces a 15,000 barrel-a-day combination thermal cracking unit and is the first catalytic cracking unit in New England. Following a six-week turnaround of all facilities excepting the asphalt plant, the modernized refinery will resume production of premium-grade gasoline which it has been unable to make since 1950.

## California Standard to Erect P-Xylene Plant at El Segundo

Standard Oil Company of California is going to put up its second p-xylene plant at its El Segundo, Calif., refinery. Humble Oil Company has licensed Standard's process and is nearing completion of a 25-million-pound-per-year plant near Houston. Two other producers are also planning to erect para plants, but it is a good assumption that Standard's second plant will keep the company as the number one producer. The second plant is scheduled to go on stream in late summer.

At El Segundo, a 40,000-barrel-a-day catalytic cracking plant will be constructed, the alkylation plant will be enlarged and the naphtha-rerun stills altered, in addition to the construction of the p-xylene plant. A 52,000-barrel-a-day residuum stripper for the cat cracker will also be built.

## U. S. Oil Company Committed On Greek Refinery Development

Of the several U. S. oil companies negotiating with individuals planning a new Greek refinery, one company is definitely committed. A government official declined to name the companies

# Consolidated announces an additional service to Southwestern users of Sulphuric Acid

To help Southwestern industries dispose of their spent sulphuric acid, Consolidated Chemical Industries Inc. has recently placed in operation at Baton Rouge, Louisiana, the largest sulphuric acid sludge burning unit ever built. This addition now permits Consolidated to decompose—and make strong new acid from — approximately 1000 tons of spent sulphuric acid per day.

The disposal of spent acid has become an increasingly serious problem for oil refineries and process industries. Many users have been forced to operate acid concentrators. Also, certain sludge disposal practices have greatly increased air pollution problems for acid users.

Consolidated's new facilities substantially eliminate the acid disposal problems of a number of Southwestern users.

The need to operate concentrators is reduced. Sulphur waste is minimized and air pollution by sulphur dioxide is reduced. Most important, the economics of handling spent acid in this manner is comparable to older forms of disposal.

We, at Consolidated, are constantly searching for better ways to serve users of heavy chemicals. We are proud of the part we have played in helping our customers solve their problems.

# Consolidated Chemical Industries Inc.

SAN FRANCISCO • HOUSTON • NEW YORK

but said several probably will be involved in different phases of the venture.

The Mutual Security Agency has said that it still has received no formal application for assistance. Italy has been tagged as the primary refining point for the Middle East in an over-all aid program; however, Italian trade restrictions have somewhat nullified the original intent, giving incentive for refinery development in Greece and Turkey, informed sources said.

## Expanding Brazil Refineries To Meet Part of Nation's Needs

Three new refineries scheduled for completion in Brazil in 1954 should enable the country to meet around 44 percent of its requirements from oil processed within its borders.

The Trade Bureau of the Brazilian government estimates that the total refinery capacity by the end of the next year will amount to around 86,000 barrels a day. Though consumption is now about 140,000 barrels a day it is expected to show a sharp rise of probably 195,000 barrels a day by the end of next year.

The principal refinery under construction in Brazil is the 45,000-barrel-a-day plant of Conselho Nacional do Petroleo at Cubatao which is located below Sao Paulo.

In addition, two refineries are being built by private Brazilian interests under refining concessions held from the government. One of these is the 20,000-barrel-a-day Capuava, Sao Paulo, refinery of Refinaria e Exploracao de Petroleo. The other is the 10,000-barrel-a-day refinery of Refinaria de Petroleos de Manguinhos at Rio de Janeiro.

Construction is also underway on an expansion of the Mataripe refinery in Bahia to raise the throughput of this plant from 2500 barrels to 5000 barrels a day.

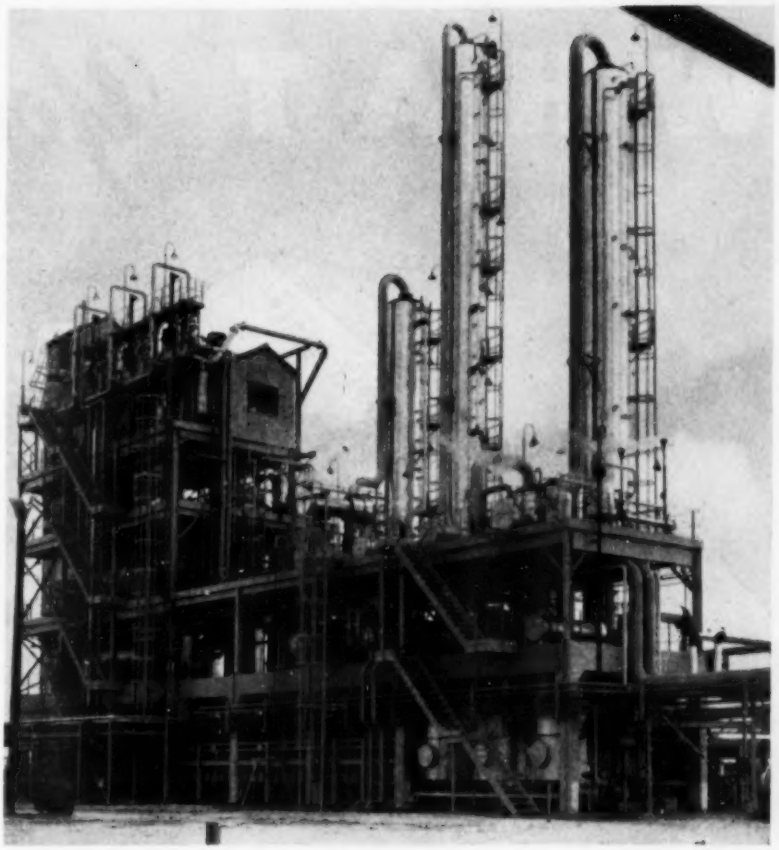
## Israel Oil Refinery Seen at Full Production Within Year

It has been seen that Israel's needs for petroleum products will be met when the Haifa refinery, jointly owned by an affiliate of Royal Dutch Shell and Anglo-Iranian Oil Company, is put back in full capacity in another year. American oil executives believe this is possible because of the upsurge of exploratory activity and the prospects of drilling within the next two or three months in the new country.

Currently the refinery is running at only a quarter to a half of its daily capacity of 83,000 barrels a day. This is a result of other Middle East countries with crude production having refused to permit any to be shipped to a country with which they are technically at war. Crude oil is currently being supplied from Venezuela through Israel Fuel Corporation, Ltd.

## Foster-Grant Switches Sites

Foster-Grant Company has announced its decision to build its multimillion dollar styrene monomer plant at Baton Rouge, La., instead of Orange, Texas. The reason for the change was the company's inability to obtain supplies of material at Orange in time to meet production schedules.



**Petrochemical Growth Forecast at Koppers Dedication—**

**Growth in the chemical production of Koppers Company, Inc., was forecast recently by Dan M. Rugg, vice president and general manager of the company's chemical division. The forecast was made at the informal dedication program for the company's new Williams petrochemical plant near Corpus Christi.**

**The operating unit of the new plant (shown above) produces ethylbenzene by combining ethylene gas and liquid benzene in the presence of a catalyst. Three towers at right of unit are distillation columns in which finished ethylbenzene is separated from other chemicals after processing. Ethylene gas is obtained through a new pipe line from the nearby refinery of Gulf Oil Corporation while benzene is purchased from coal carbonization plants and oil refineries in many parts of the country, including Texas.**

**Begun in 1951 the new Williams plant was designed and built by Koppers Engineering and Construction division. Partial production began some months ago but only recently has it been on a full operating schedule.**

## Shell Passes Halfway Mark in Melbourne Plant Construction

Construction of the new 25,000-barrel-a-day refinery of Shell Oil Company of Australia, Ltd., at Geelong, near Melbourne, has passed the halfway mark.

The Geelong refinery is being built on a 250-acre site and is scheduled to go into operation the middle of next year. Crude for the plant will be supplied from Shell's Seria field in British North Borneo.

## Electrolytic Process Licensed

Leonard Refineries, Inc., of Alma, Mich., has contracted with American Development Corporation, New York, for a license to use the electrolytic process for regeneration of spent alkaline solutions at the company's 9000-barrel-a-day Alma refinery. The new plant will be used to regenerate the caustic soda employed in treating catalytic cracked gasoline and other products.

## McMurrey Refinery Set to Start Extensive Expansion at Tyler

Construction of facilities to double the crude throughput and to permit production of aviation gasoline for military use will start soon at the 12,500-barrel-a-day refinery of McMurrey Refining Company, Tyler, Texas.

Presently in the design stage are a 12,500-barrel-a-day crude distillation unit; an 8000-barrel-a-day decarbonizing unit to prepare catalytic cracking feed and make coke; a 5000-barrel-a-day Platforming unit, and a 1400-barrel-a-day HF alkylation unit. The plant now has an 8000-barrel-a-day Fluid cracking unit, thermal cracking and poly gasoline facilities.

A DPA amortization certificate has been received. Construction is scheduled for completion by year's end.

Contracts have been awarded to the Chemical Plants division, Blaw-Knox Construction Company, for the crude and feed preparation units. Procon, Inc.,

# WHAT You Need

# WHEN YOU NEED IT

# WHERE YOU NEED IT

PESA
PARTNERS IN PETROLEUM PROGRESS

To have the right equipment, at the right place, at the right time is the purpose of the over 900 supply stores serving the oil industry. Huge inventories of all types of materials in every oil producing area are carried for the convenience and service of all phases of the oil industry.

Realizing that minutes mean money to oil men, this tremendous field stock is maintained so that you will have what you need, when you need it and where you need it. This is the time-saving, cost-saving way to get what you want — when you want it.

This company maintains six field warehouses at strategic locations —

**AND REMEMBER THAT YOUR SUPPLY STORE IS A NORRIS DISTRIBUTOR.**

## W. C. NORRIS MANUFACTURER, INC.

TULSA, OKLAHOMA

WEST COAST DISTRIBUTORS:

BRANCHES:

EXPORT:

will build the platformer. Other contracts have not yet been let.

The existing thermal cracker, now in part used to prepare feed for catalytic cracking, will be modernized and returned to two-coil thermal cracking duty at about 8500-barrel-a-day capacity.

## AIOC Plans New Installations At Four Continental Plants

Anglo-Iranian Oil Company, Ltd., has announced that major new units will be installed at four of six continental refineries owned by AIOC and its associates. At the Antwerp refinery, jointly owned by AIOC and Petrofina, a catalytic cracker and a catalytic polymerization unit will be added to raise the quality of motor "spirit." The existing thermal cracker will be modified so that it can process another 17,000 barrels a day if required.

In Germany, a new distillation unit is being built at the Hamburg refinery, raising distillation capacity to about 24,000-barrel-a-day and a Platformer will go in to step up motor spirit quality. At Schindler lubricating oils refinery nearby, a new furfural treating plant is being installed.

The Dunkirk refinery, owned by Anglo-Iranian's French associate, Societe Generales des Huiles de Petrole B.P., will also have a 24,000-barrel-a-day Platformer installed.

## Gasoline Production Raised By Two California Refiners

Union Oil Company estimates that this year gasoline production at its Los Angeles refinery will be approximately 64,000 barrels a day. This production is expected following completion of a $24 million modernization and enlargement program at the plant.

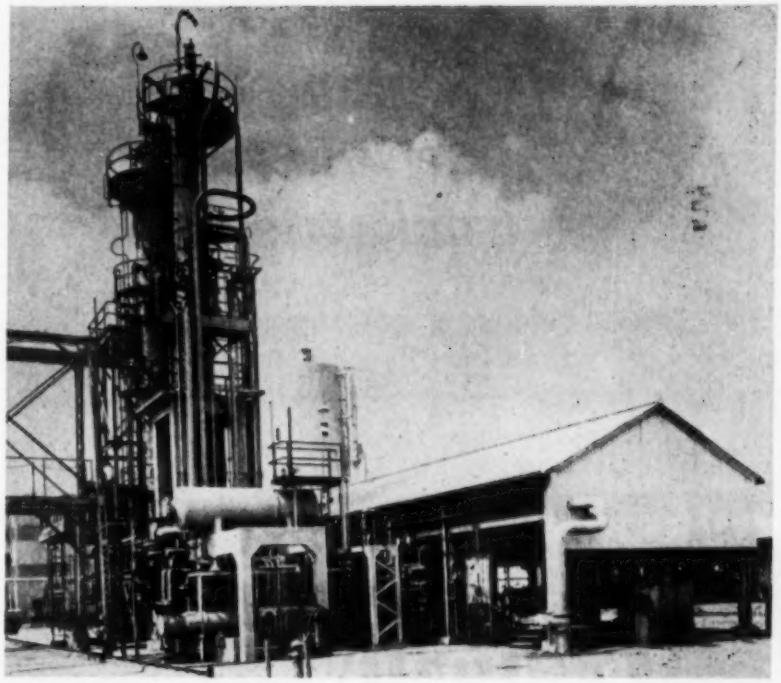
This recovery will represent a yield of about 40 percent from the raw materials charged. It will compare with a 36.4 percent yield and 54,000 barrels daily which was being obtained last year before some of the new units were placed on stream.

Richfield Oil Corporation reported similar higher gasoline recoveries. This increase is due to completion of improvements at its Watson, Calif., plant in mid 1952. Prior to the work, 55.6 percent gasoline and middle distillates and 41.4 percent residual fuels were being obtained. Since completion of the $3.9 million expenditure, the yields have been 64 and 31.9 percent, respectively.

## Cooper-Bessemer Gets Contract For Ohio Standard Compressors

Contract for building two 1000-horsepower gas compressors for the new Catalytic reformer unit at the Lima refinery of The Standard Oil Company (Ohio) has been awarded to Cooper-Bessemer Corporation. Procon, Inc., of Chicago, the general contractor on the Lima job, made the selection.

The two gas compressors, to be delivered in the fall, will cost $145,000. Each is a six cylinder motor driven unit and will have a key part in the operation of the 12,000-barrel-a-day cat reformer. The new catalytic reformer unit will cost $7.5 million and is expected to be in operation by the spring of 1954.



**Shell Chemical Hikes Epichlorohydrin Production—**

**An ample supply of epichlorohydrin for both the present and future needs of the nation can well be supplied by the new plant which Shell Chemical Corporation has brought on stream in Houston.**

**Epichlorohydrin, of which Shell Chemical is the only large supplier, has recently become a key chemical product. Not only is it a major component of epoxy resins, but it is also used in adhesives and chemical intermediates, and as a stabilizer in insecticides.**

**Part of the new epichlorohydrin production will be tied in with the expansion of Shell's facilities for manufacturing epon resins. Now in tight supply, epon resins will remain so until next fall when Shell Chemical brings in its new bis-phenol and epon resins plant in Houston.**

# Allied Chemical and Mathieson Head Latest ODM Tax Write-Offs

Two chemical companies topped the Office of Defense Mobilization's latest list of quick tax amortization allowances.

The largest write-off grant went to Allied Chemical & Dye Corporation. ODM authorized the firm to write off 40 percent and 60 percent of portions of $27 million over a five-year period instead of the longer period normally required by the government for depreciation of such production facilities. The company plans to invest the amount in facilities to manufacture phosphate fertilizers at La Platte, Nebr., and monomer plastics for military use at Baton Rouge, La.

Mathieson Chemical Corporation received the second largest write-off going to companies in the oil and related industries. ODM authorized it to amortize at the fast rate 45 percent of $21 million, which will be used for phosphatetic fertilizer facilities.

Other companies granted ODM approval, with location, type of facility, amount certified and tax write-off rate:

Standard Oil Company (Indiana)—Casper, Wyo., aviation alkylate, $1.4 million, 100 percent; $189,000, 65 percent.

Standard Oil Company (Indiana)—Whiting, Ind., petroleum refining, $1 million, 65 percent; $89,000, 40 percent.

The Standard Oil Company (Ohio)—Cleveland, petroleum refining, $960,000, 65 percent.

United Refining Company — Warren, Pa., petroleum refining, $50,000, 40 percent.

Dakota Oil & Refining Company—Minot, N. Dak., petroleum refining, $869,800, 65 percent; $292,090, 40 percent; $48,200, 15 percent.

Phillips Petroleum Company—Phillips, Texas, special facilities for aviation gasoline, $58,400, 90 percent; $51,000, 90 percent.

The Atlantic Refining Company—Lea County, N. M., petroleum refining, $413,400, 25 percent; $395,060, 40 percent; $3.5 million, 65 percent.

Sunray Oil Corporation—Tulsa, petroleum refining, $1.3 million, 65 percent.

Pacific Oil & Refining Company—Tacoma, Wash., petroleum refining, $1.3 million, 45 percent; $4.3 million, 65 percent; $75,500, 15 percent.

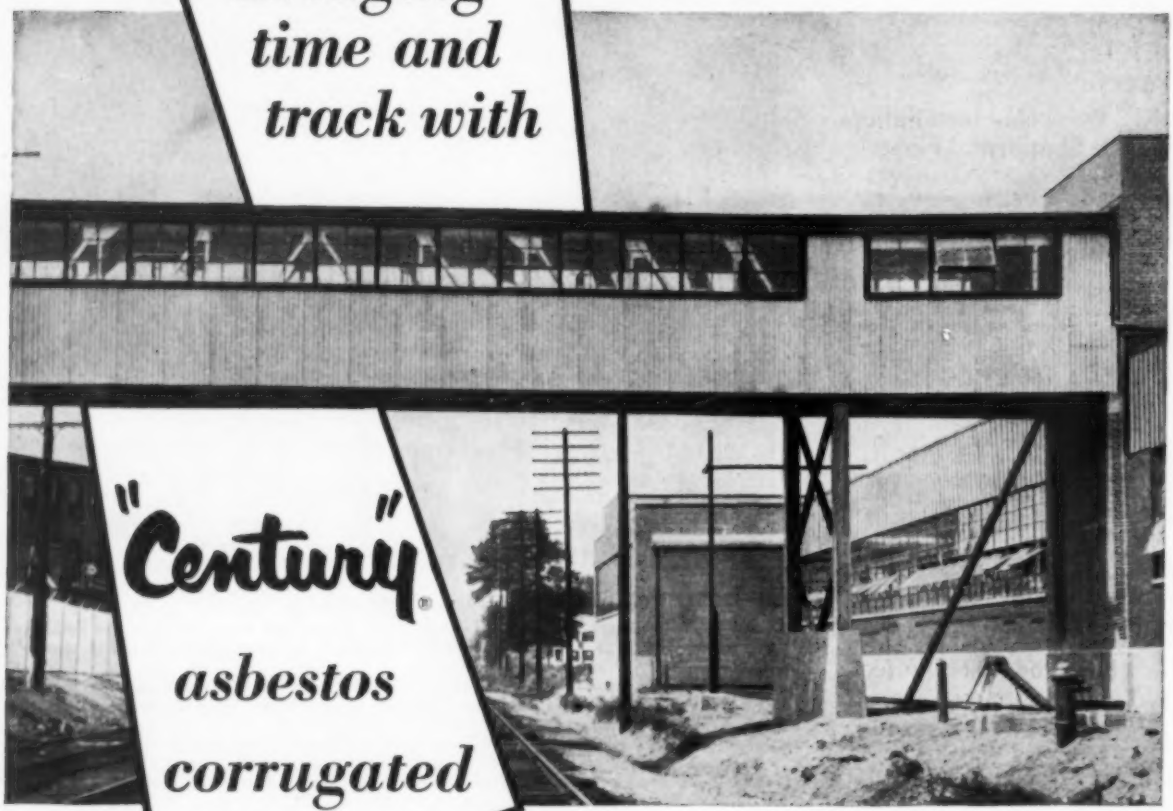
Shell Chemical Corporation—Norco, La., isopropyl alcohol for acetone production, $6.5 million, 50 percent; $370,000, 15 percent.

Shell Chemical Corporation—Houston, acetone, $297,000, 50 percent.

Shell Chemical Corporation—Dominques, Calif., methyl isobutyl ketone, $400,000, 50 percent.

Ashland Oil & Refining Company—

# *Bridging time and track with*



## *"Century"® asbestos corrugated*

Inter-plant bridge of the Trumbull Electric Department of the General Electric Co. in Plainville, Conn. Sidewalls of bridge and the building on the right constructed of "Century" Asbestos Corrugated, and applied by Hampden Cornice Works Inc., Springfield, Mass. Supervisor of Construction: General Electric Realty Corp., Schenectady, N.Y. Engineer and Architect: Lockwood Greene Engineers Inc., New York, N.Y. General Contractor: The Gellatly Construction Co., Bridgeport, Conn.

"Century" Asbestos Corrugated makes an ideal siding for this new inter-plant bridge and building because of its outstanding durability and freedom from maintenance. After many years this long-lived siding will still be sound, serviceable, and weather-tight.

If that's the kind of dependable siding and roofing *you* are seeking, you ought to know more of the many advantages in using "Century" Asbestos Corrugated. Here are a few facts about this versatile, economical material:

It is made in large, strong sheets from portland cement and asbestos fiber—therefore *cannot* burn, rot or rust. It is impervious to rodents and termites. It is completely, permanently weatherproof. Although it never needs paint, it will take decorative colors well.

"Century" Asbestos Corrugated has proved itself to be a maintenance-free and long-lasting building material—well worth your close consideration. We shall gladly send you complete information on request.

*Nature made Asbestos . . .*
*Keasbey & Mattison has made it serve mankind since 1873.*

K&M best in asbestos®

**KEASBEY & MATTISON**
COMPANY • AMBLER • PENNSYLVANIA

Catlettsburg, Ky., petroleum refining, $1 million, 100 percent; $2.25 million, 65 percent; $185,000, 40 percent.

The Pure Oil Company—Toledo, specialized facilities for aviation gasoline, $257,000, 100 percent; $50,100, 40 percent.

American Mineral Spirits Company—Toledo, aviation alkylate, $3.7 million, 100 percent.

Shell Oil Company—Wood River, Ill., petroleum refining, $850,000, 20 percent.

Pan American Refining Corporation—Texas City, Texas, petroleum refining, 50 percent.

## Pemex Considering Plans for Building New Tampico Refinery

Plans for construction of a new refinery at Tampico, in the State of Tamaulipas, are being considered by Petroleos Mexicanos. The proposed refinery would be designed to handle heavy crude, including that produced at Tenixtepec, Naranjos and Panuco fields.

The three existing refineries in the Tampico district all date from the pre-expropriation days and have been little improved since that time. Their aggregate capacity is about 110,000 barrels a day; however, runs are considerably below this. Much of the equipment is considered completely worn out. The Cuidad Madero refinery, built originally by Shell Oil Company, is the largest with a rated capacity of 71,000 barrels a day.

Pemex plans also to modernize its Isthmus refinery at Minatitlan. This plant, now charging around 20,000 barrels a day of local crude, will be boosted to 40,000-barrels-a-day capacity. The topping facilities will have to be rebuilt, and a 7500-8000-barrel-a-day catalytic cracking unit installed.

Long-range refining plans of Pemex provide for the construction of three new 10,000-barrel-a-day refineries on the West Coast. These are expected to be located at Guaymas, Salina Cruz and Mazatlan.

Other expansion plans of Pemex were contained in its recent annual report which said that the capacity of the Atzcapotzalco refinery in Mexico City would be increased from 50,000 to 80,000 barrels a day during the current year. Capacity at Salamanca will also be raised from 30,000 to 40,000 barrels, while throughput at the Reynosa plant will be brought to 7000 barrels a day.

## Contracts Awarded for Project At California Standard Plant

Standard Oil Company of California has awarded contracts for the catalytic cracking project and para xylene plant to be built at its El Segundo, Calif., refinery.

Awards are as follows:

To Fluor Corporation of Los Angles—construction of a 40,000-barrel-a-day cat cracking plant; an addition to the alkylation plant and alterations to the naphtha return stills; and construction of the para xylene plant.

To The M. W. Kellogg Company of New York—construction of a 52,000-barrel-a-day residuum stripper for the cat cracking project.

To Macco Corporation of Paramount, Calif.—installation of off-site facilities required for the cat cracking project and para xylene plant.

**Gasoline Plant Committee Awards Plaques—**

**Handsome bronze wall plaques commemorating services on the Snyder, Texas, gasoline plant advisory committee were recently awarded to J. C. Birdsall, Bartlesville, and Frank Perry, Corpus Christi. They have retired from the committee membership after serving since its organization in 1950.**

**Pictured above from the left: Ernest J. Mills, manager of gasoline plant operations for Sunray Oil Corporation, operators of the Snyder plant; H. W. Manley, Sunray vice president and manager of the company's manufacturing, sales and pipe line department who made the presentation in Tulsa as chairman of the advisory committee; Birdsall, who is associated with the L. M. Lockhart organization, and Perry, of Cities Service Oil Company.**

**The plaque was engraved with an air photograph of the Scurry County unit and names of all committee members joining in the presentation.**

## Procon Gets Sohio Contract For Platformer Operating Units

The Standard Oil Company (Ohio) has signed a contract with Procon, Inc., for construction of the operating units for a new catalytic platformer at the Lima, Ohio, refinery.

Construction is scheduled to begin in July. It is estimated that it will take about a year to build the 12,000-barrel-a-day plant, which will convert low-octane gasoline into high-octane gasoline. Construction by Procon will cost about $4 million, with total cost of the platformer set at $7.5 million.

The new construction will replace an old thermal reformer. This type of catalytic reformer will use a Universal Oil Products Company created process.

## Refinery Operators to Start Canadian Refinery in July

Refinery Operators, Ltd., will begin construction of a $6 million oil refinery near Kamloops, B. C., in July. It will have a capacity of 5000 barrels a day. The project will include a catalytic cracking unit enabling the refinery to produce a complete line of petroleum products.

Refinery Operators, a privately owned enterprise, has obtained options on land parallel to the Trans Mountain Oil Pipe Line Company pipe line. The project is being financed with Canadian capital.

## Dow Chemical Announces Plans For New Polyethylene Plant

The Dow Chemical Company has announced plans to build a new polyethylene plant at Freeport, Texas. Construction of plant facilities, prior to plant production, is estimated to take between 18 and 24 months. Negotiations for patent licenses have been made with Imperial Chemical Industries, Ltd., a British firm.

## Imperial Chemical Schedules Canadian Dacron Fiber Plant

Imperial Chemical Industries, Ltd., of Great Britain, will build a factory in Canada to turn out dacron fiber. According to the firm, the plant will cost over $20 million and be able to produce some 11 million pounds of the material a year.

The company has made no definite date for construction or production to begin, but it reported that the site has already been acquired and building would start "at an early date." The plant is to be located at Milhaven, near Kingston, Ontario.

## Texaco Awards Contract for Expansion of Amarillo Plant

The M. W. Kellogg Company has been awarded the contract in connection with complete moderinization of The Texas Company's 8000-barrel-a-day Amarillo, Texas, refinery.

Kellogg-designated units will include a 15,500-barrel-a-day crude distillation unit, a 3600-barrel-a-day delayed coking unit, a 6000-barrel-a-day Orthoflow Fluid catalytic cracking unit, and a catalytic polymerization unit rated at about 470 barrels a day of polymer gasoline. The first two facilities will be integrated into a combination unit.

## New 1500-Barrel-a-Day Refinery Announced for Williston Basin

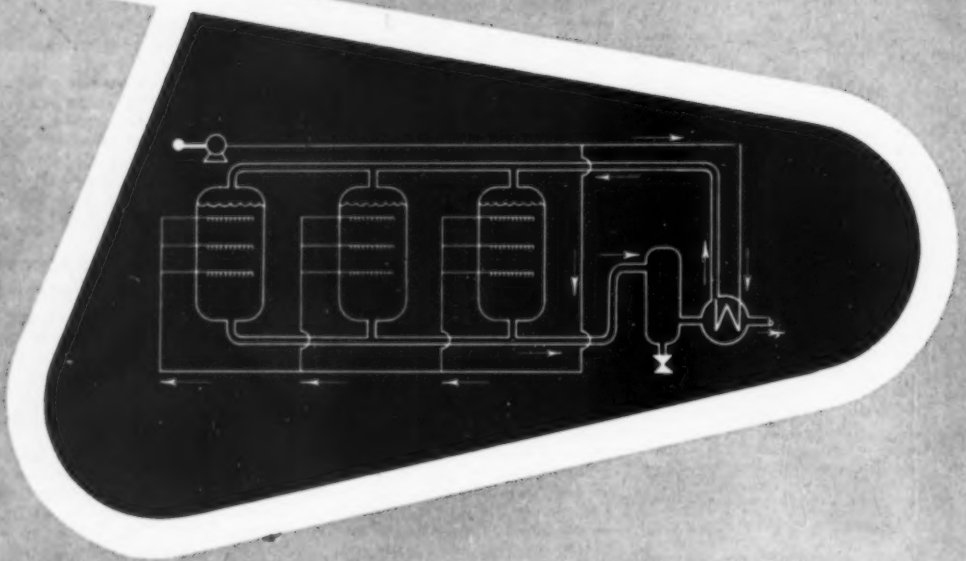
A program for the construction of a 1500-barrel-a-day refinery on the east side of the Williston, N. D., city limits has been inaugurated by the businessmen in that city. The plant will be built and operated by a new firm, Williston Basin Refining Company.

**SEE PAGE 254 FOR MORE CONSTRUCTION ITEMS.**

# HYDROCARBON

**Planned Processing for Profit**

**"California" CATALYTIC POLYMERIZATION**



When your refinery operations suggest upgrading your propylene and butylenes, Hydrocarbon Research offers the "California" catalytic polymerization process to produce high value polymer gasolines, codimer and high purity cumene. The process is simple, highly efficient, and—*unique*.

**Low Catalyst Cost:** Low cost, easily available, phosphoric acid, supported as a liquid film on quartz particles that stay in place during the catalyst regeneration.

**High "On-Stream" Time:** Regeneration is a simple "valve twisting," water-wash operation.

**Low Maintenance Cost:** The operator makes the catalyst change; no catalyst "mining" crews are required.

**High Product Quality:** Polymerization by surface reaction prevents over-polymerization caused by absorption.

**HYDROCARBON "KNOW-HOW"** is based on the design of eleven units—several in successful operation—others under construction—ranging in capacity from 230 BPD up to the world's largest—4650 BPD. Hydrocarbon alone can give you *complete service* including licensing, designing and erection. Talk to Hydrocarbon about your needs now.

**HYDROCARBON RESEARCH, INC.**
**115 Broadway, New York 6, N. Y.**
**Cable: Hydrocol**

HRI
PLANNED PROCESSING FOR PROFIT

**TRENTON, NEW JERSEY**—Hydrocarbon Research, Inc., Development Laboratory, P. O. Box 1419.
**PARIS, FRANCE**—Hydrocarbon Engineering, S.a.r.L. 44, Avenue des Champs-Élysées, Cable: Hydrocarbon.
**DUESSELDORF, GERMANY**—Hydrocarbon Mineraloel, G.m.b.H., 15-17 Fuerstenwall. Cable: Hydromin.
**RIO DE JANEIRO, BRAZIL**—General Heitor Pedroso, Rua da Quintanda, 20, Sala 801. Cable: Bispetro.
**NEW DELHI, INDIA**—A. R. Palit & Company, Sujan Singh Park, Post Box 671, Cable: Palitar

8109

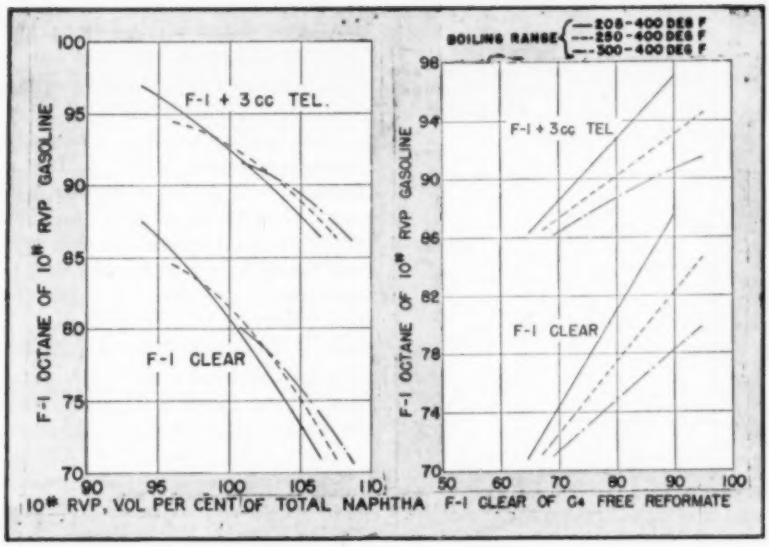



Figure 1: In the lower octane range, a greater yield from the narrower-boiling stock . . .




Figure 2: For a given reformate octane, a higher finished gasoline octane number with the wider-boiling stock . . .

# How Feed Stock and Severity . . .

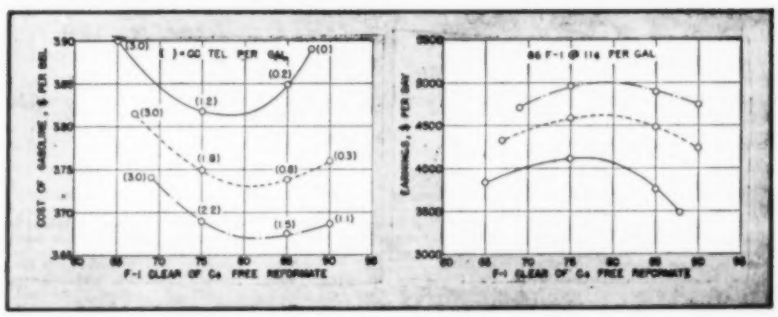



Figure 3: 86 octane gasoline at least cost by reforming the narrower-boiling naphtha . . .




Figure 4: Maximum earnings with narrower-boiling stock by reforming to a moderate octane . . .

# . . . Affect Houdriforming Economics

- Least cost by reforming the narrowest-boiling naphtha
- Highest earnings by moderate severity

**H. D. Noll, T. A. Burtis, J. C. Dart,**
Houdry Process Corporation,
Philadelphia

FILLING THE GAP in the literature on catalytic reforming, this paper illustrates the economic selection of charge-stock boiling range and severity for the Houdriforming of a typical sweet naphtha. It is shown that a finished gasoline of a given octane number can be produced at least cost by the reforming of the narrowest-boiling 400-F-end-point naphtha with which it is possible to reach the desired octane level. Furthermore, lowest cost and highest earnings are realized when Houdriforming severity is moderate, i.e., from 78 to 82 ASTM research octane number. In general, it is best to reform to a moderate severity the lowest octane-number component of the straight-run naphtha. An increase in octane requirement or a decrease in the allowable concentration of tetraethyllead may compel the inclusion of lower-boiling fractions in the charge. In the past few years many papers describing the performance of catalytic reforming processes have appeared. It has been adequately demonstrated that catalytic reforming is more efficient than thermal reforming. Further, most refiners recognize that catalytic upgrading of straight-run naphthas is now, or shortly will be, a necessity. However, it is true that, once a decision has been made to install catalytic reforming, there still remains the problem of determining what cut of naphtha should be reformed, and to what severity. Little has been published on this subject. In order to illustrate a solution to this problem, a study has been made of the effect of boiling range and reforming severity on the economics of reforming. This paper summarizes the results of this work as applied to the selection of charge stocks for Houdriforming.

The study is based on processing 5000 barrels per day of a full-range naphtha of low sulfur content. The naphtha selected is actually a mixture derived from several crude oils and, therefore, cannot be accurately classified by source. In catalytic reforming, however, the crude source itself is less important than the chemical composition of the naphtha. The naphtha used here has a naphthene content of approximately 42 percent, and would be characterized as a good reforming charge stock, representative of many which are available in this country.

From the full-range IBP-400 F. naphtha, 3 Houdriforming charge stocks were prepared comprising these

Original presentation as "Houdriforming Economics—Effect of Feed-Stock Boiling Range and Reforming Severity" was at the 18th Mid-Year Meeting of API's Division of Refining, New York, May 13, 1953.

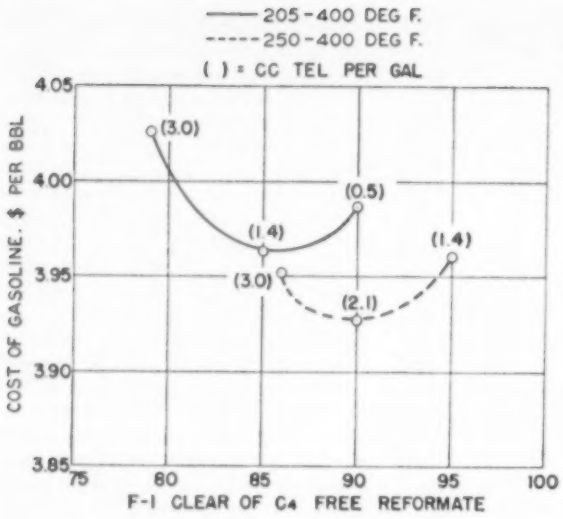



Figure 5: Cost of producing 92-octane number 10-pound-RVP gasoline.

fractions of the naphtha: 205-400 F., 250-400 F., and 300-400 F. Inspections of these materials, as well as their associated light straight-run gasolines, are given in Table 1.

Each fraction was Houdriformed at several conditions to give $C_4$-free reformates with an octane number, without TEL addition, of 75 to 95 by ASTM research method D 908.* The reformates were then blended with the appropriate straight-run gasoline cuts, and pressured to a Reid vapor pressure of 10 pounds. The over-all relationships between yield and octane number are shown in Figure 1, which is a plot of the yield of 10-pound-

* Octane numbers in this paper are all by ASTM research method D 908.

**TABLE 2**

**Cost of Producing 86-Octane-Number † 10-Pound-RVP Gasoline**

(5000 Bbl Per Calendar Day, Total Straight-run)

| Charge-Stock Boiling Range | | 205-400 F. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Houdriformer Capacity (Barrels per Calendar Day) | | 3,930 | | | | | | | |
| CASE: | | I | | II | | III | | IV | |
| ASTM D 908 Reformate (Without TEL Addition) | | 65 | | 75 | | 85 | | 87.8 | |
| 10-Lb.-RVP Gasoline (Barrels per Calendar Day) | | 5,319 | | 5,120 | | 4,864 | | 4,770 | |
| **DEBIT:** | **Unit Cost** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** |
| Total straight-run naphtha, per barrel | $3.36 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 |
| Purchased butanes, per barrel | $2.10 | 484 | 1,017 | 355 | 735 | 198 | 416 | 148 | 311 |
| Fuel gas (FOE‡), per barrel | $1.98 | —78 | —154 | —147 | —291 | —248 | —491 | —288 | —570 |
| Tetraethyllead (milliliters per gallon), cents per milliliter | 0.22 | 2.9 | 1,422 | 1.2 | 567 | 0.2 | 90 | 0 | |
| Sub-total | | | 19,085 | | 17,811 | | 16,815 | | 16,541 |
| Fixed charges | | | 479 | | 479 | | 479 | | 479 |
| Direct operating cost (labor, utilities, catalyst, and royalty) | | | 1,180 | | 1,252 | | 1,444 | | 1,539 |
| Sub-total | | | 1,659 | | 1,731 | | 1,923 | | 2,018 |
| Total cost | | | 20,744 | | 19,542 | | 18,739 | | 18,559 |
| Cost, dollars, per barrel | | | 3.90 | | 3.82 | | 3.85 | | 3.89 |
| **CREDIT:** | | | | | | | | | |
| 10-lb-RVP gasoline, per barrel | $4.62 | | 24,574 | | 23,654 | | 22,472 | | 22,037 |
| Earnings | | | 3,830 | | 4,112 | | 3,748 | | 3,478 |
| **Charge-Stock Boiling Range** | | 250-400 F. | | | | | | | |
| **Houdriformer Capacity (Barrels per Calendar Day):** | | 2,880 | | | | | | | |
| CASE: | | V | | VI | | VII | | VIII | |
| ASTM D 908 Reformate (without TEL Addition) | | 67 | | 75 | | 85 | | 90 | |
| 10-Lb-RVP Gasoline (Barrels per Calendar Day) | | 5,374 | | 5,266 | | 5,078 | | 4,947 | |
| **DEBIT:** | **Unit Cost** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** |
| Total straight-run naphtha, per barrel | $3.36 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 |
| Purchased butanes, per barrel | $2.10 | 514 | 1,070 | 418 | 878 | 309 | 649 | 231 | 485 |
| Fuel gas (FOE‡), per barrel | $1.98 | —58 | —114 | —98 | —194 | —169 | —335 | —224 | —444 |
| Tetraethyllead (milliliters per gallon), cents per milliliter | 0.22 | 2.9 | 1,440 | 1.8 | 876 | 0.8 | 366 | 0.35 | 155 |
| Sub-total | | | 19,196 | | 18,380 | | 17,480 | | 16,996 |
| Fixed charges | | | 414 | | 414 | | 414 | | 414 |
| Direct operating cost (labor, utilities, catalyst, and royalty) | | | 894 | | 946 | | 1,087 | | 1,211 |
| Sub-total | | | 1,308 | | 1,360 | | 1,501 | | 1,625 |
| Total cost | | | 20,504 | | 19,740 | | 18,981 | | 18,621 |
| Cost, dollars, per barrel | | | 3.82 | | 3.75 | | 3.74 | | 3.76 |
| **CREDIT:** | | | | | | | | | |
| 10-lb-RVP gasoline, per barrel | $4.62 | | 24,828 | | 24,329 | | 23,460 | | 22,855 |
| Earnings | | | 4,324 | | 4,589 | | 4,479 | | 4,234 |
| **Charge-Stock Boiling Range** | | 300-400 F. | | | | | | | |
| **Houdriformer Capacity (Barrels per Calendar Day):** | | 1,980 | | | | | | | |
| CASE: | | IX | | X | | XI | | XII | |
| ASTM D 908 Reformate (without TEL Addition) | | 69 | | 75 | | 85 | | 90 | |
| 10-Lb-RVP Gasoline (Barrels per Calendar Day) | | 5,425 | | 5,365 | | 5,239 | | 5 141 | |
| **DEBIT:** | **Unit Cost** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** | **Volume (BPCD*)** | **Dollars per Calendar Day** |
| Total straight-run naphtha, per barrel | $3.36 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 |
| Purchased butanes, per barrel | $2.10 | 510 | 1,070 | 470 | 987 | 389 | 817 | 335 | 404 |
| Fuel gas (FOE‡), per barrel | $1.98 | —42 | —83 | —63 | —125 | —114 | —226 | —151 | —299 |
| Tetraethyllead (milliliters per gallon), cents per milliliter | 0.22 | 3.0 | 1,505 | 2.2 | 1,090 | 1.5 | 726 | 1.1 | 523 |
| Sub-total | | | 19,292 | | 18,752 | | 18,117 | | |
| Fixed charges | | | 350 | | 350 | | 350 | | 350 |
| Direct operating cost (labor, utilities, catalyst, and royalty) | | | 654 | | 689 | | 787 | | 872 |
| Sub-total | | | 1,004 | | 1,039 | | 1,137 | | 1,222 |
| Total cost | | | 20,296 | | 19,791 | | 19,254 | | 18,950 |
| Cost, dollars, per barrel | | | 3.74 | | 3.69 | | 3.675 | | 3.69 |
| **CREDIT:** | | | | | | | | | |
| 10-lb-RVP gasoline, per barrel | $4.62 | | 25,000 | | 24,750 | | 24,150 | | 23,700 |
| Earnings | | | 4,704 | | 4,959 | | 4,896 | | 4,750 |

* BPCD—barrels per calendar day. † ASTM D 908 (research method) ‡ FOE—fuel-oil equivalent.

RVP gasoline (expressed as percent of full-range naphtha) against the octane number of the finished gasoline. It will be noted that these relationships of yield vs. octane number for all three cuts are quite similar. In the lower octane range a somewhat greater yield of finished gasoline is obtainable from the narrower-boiling heavy charge stocks. However, as the octane level is increased, the advantage disappears, and eventually the curves cross so that a better relationship is obtained with the wide-cut charge stock.

A further correlation which is pertinent to the study is shown in Figure 2. Here the octane number of the 10-pound-RVP gasoline is plotted against the octane number (without TEL addition) of the $C_4$-free reformate. These curves show that, for a given reformate octane number, a higher finished gasoline octane number is obtained with the wider-boiling charge stock. It is also apparent that the octane ceiling is higher for the wider boiling-range material.

The economic evaluation was carried out by fixing a finished gasoline octane level; then calculating the cost of producing the gasoline by reforming the three charge stocks at varying severities. The costs include full-range naphtha, purchased butanes, tetraethyllead, and fuel-gas credit. Direct operating costs and fixed charges (10 percent depreciation, 4 percent maintenance) are also included. Basic values assigned for the comparisons were as follows:

| | |
|---|---|
| IBP-400 F. naphtha, per gallon | $0.08 |
| Butanes, per gallon | 0.05 |
| Tetraethyllead, per milliliter | 0.0022 |
| Fuel, per barrel | 1.98 |
| Steam, per 1000 pounds | 0.55 |
| Power, per kilowatt-hour | 0.01 |
| Water, per 1000 gallons | 0.01 |

Labor rates were assumed to be $2.00 per hour.

The first situation considered was the production of 86-octane-number 10-pound-RVP gasoline. A summary of the cases is given in Table 2. The results are shown graphically in Figure 3. Inspection of Figure 3 shows immediately that the 86-octane-number gasoline can be made at least cost by reforming the narrower-boiling heavy naphtha. It shows further that, for each naphtha, there is a reforming severity which entails minimum cost. In the case of the 300-400 F. naphtha the least cost occurs when the reformate octane number is approximately 81 clear. At this point gasoline costs $3.67 per barrel. The minimum cost for processing the 250-400 F. naphtha is $3.73 per barrel, and this point occurs also at about 81 clear octane number. Finally, the minimum cost for the 205-400 F. naphtha is $3.81 per barrel, and this occurs at a reforming severity of approximately 78 clear octane number. It should particularly be noted that the most economical operation is not represented by maximum reforming severity. On the contrary, moderate reforming severities in the octane-number range of 78 to 82 clear are most advantageous, and the use of 1 to 2 ml TEL per gallon of finished gasoline represents the least cost. The most significant conclusion to be drawn from these curves is that, when a full-range naphtha is to be upgraded, it is most desirable to accomplish this by reforming the lowest octane fraction which will give the required final quality.

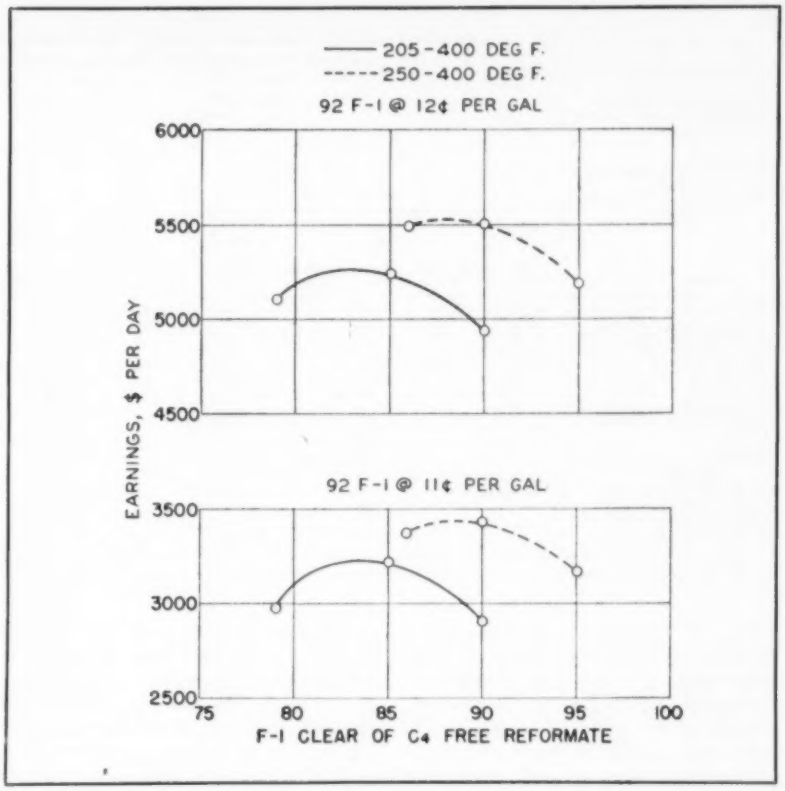



Figure 6: Earning when 92-octane number 10-pound-RVP gasoline is produced.

These same calculations can be evaluated from the standpoint of earnings, rather than cost, by assigning a value to the finished gasoline. This has been done in Figure 4, in which gasoline with an 86 octane number has been assigned a value of 11 cents per

**TABLE 1**
**Charge-Stock Inspections**

| FRACTION: | Full Range | 205-400 F. | 250-400 F. | 300-400 F. | IBP-205 F. | IBP-250 F. | IBP-300 F. |
|---|---|---|---|---|---|---|---|
| Percent by volume of crude | 24.3 | 19.1 | 14.0 | 9.6 | 5.2 | 10.3 | 14.7 |
| Gravity, degree, API | 55.6 | 51.6 | 49.5 | 47.6 | 67.9 | 62.9 | 60.0 |
| **ASTM Distillation, Fahrenheit:** | | | | | | | |
| Initial boiling point | 116 | 205 | 252 | 298 | .... | .... | .... |
| 10 percent point | 186 | 224 | 282 | 318 | .... | .... | .... |
| 30 percent point | 234 | 244 | 309 | 335 | .... | .... | .... |
| 50 percent point | 270 | 307 | 329 | 352 | .... | .... | .... |
| 70 percent point | 315 | 326 | 347 | 371 | .... | .... | .... |
| 90 percent point | 355 | 358 | 376 | 387 | .... | .... | .... |
| End point | 392 | 397 | 400 | 402 | .... | .... | .... |
| Reid vapor pressure, lb | .... | 0.8 | 0.7 | 0.6 | 13.0 | 7.1 | 5.2 |
| Sulfur, percent | 0.02 | .... | .... | .... | .... | .... | .... |
| **Octane Number (ASTM D 908, Research Method):** | | | | | | | |
| Without TEL addition | 58.8 | 56.6 | 52.5 | 49.7 | 73.7 | 67.1 | 65.7 |
| With addition of 3 ml TEL per gallon | 77.2 | 77.0 | 75.0 | 73.0 | 89.5 | 85.0 | 83.5 |
| Paraffins, percent | 57 | 42 | 41 | 40 | 61 | 54 | 53 |
| Olefins, percent | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Naphthenes, percent | 41 | 45 | 45 | 46 | 36 | 41 | 39 |
| Aromatics, percent | 2 | 13 | 14 | 14 | 3 | 5 | 8 |

**TABLE 3**

**Cost of Producing 92-Octane-Number † 10-Pound-RVP Gasoline**

(5000 Bbl Per Calendar Day, Total Straight-run)

| Charge-Stock Boiling Range | | 205-400 F. | | | | | | 250-400 F. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Houdriformer Capacity (Barrels per Calendar Day): | | 3,930 | | | | | | 2,850 | | | | | |
| CASE: | | XIII | | XIV | | XV | | XVI | | XVII | | XVIII | |
| ASTM D 908 Reformate (without TEL Addition) | | 79 | | 85 | | 90 | | 86 | | 90 | | 95 | |
| 10-Lb-RVP Gasoline (Barrels per Calendar Day) | | 5,025 | | 4,864 | | 4,688 | | 5,055 | | 4,947 | | 4,801 | |
| **DEBIT** | **Unit Cost** | **Volume (BPCD*)** | **Dollars Per Calendar Day** | **Volume (BPCD*)** | **Dollars Per Calendar Day** | **Volume (BPCD*)** | **Dollars Per Calendar Day** | **Volume (BPCD*)** | **Dollars Per Calendar Day** | **Volume (BPCD*)** | **Dollars Per Calendar Day** | **Volume (BPCD*)** | **Dollars Per Calendar Day** |
| Total straight-run naphtha, per bbl | $3.36 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 | 5,000 | 16,800 |
| Purchased butanes, per barrel | $2.10 | 300 | 630 | 198 | 416 | 103 | 216 | 292 | 614 | 231 | 485 | 150 | 315 |
| Fuel gas (FOE‡), per barrel | $1.98 | −182 | −360 | −248 | −491 | −325 | −634 | −178 | −352 | −224 | −444 | −284 | −562 |
| Tetraethyllead (milliliters per gal.) cents per milliliter | 0.22 | 3.0 | 1,391 | 1.4 | 630 | 0.5 | 217 | 3.0 | 1,400 | 2.1 | 960 | 1.4 | 621 |
| Sub-total | | | 18,461 | | 17,355 | | 16,599 | | 18,462 | | 17,801 | | 17,174 |
| Fixed charges | | | 479 | | 479 | | 479 | | 414 | | 414 | | 414 |
| Direct operating cost, (labor, utilities, catalyst, and royalty) | | | 1,287 | | 1,444 | | 1,613 | | 1,101 | | 1,211 | | 1,419 |
| Sub-total | | | 1,766 | | 1,923 | | 2,092 | | 1,515 | | 1,625 | | 1,833 |
| Total cost | | | 20,227 | | 19,278 | | 18,691 | | 19,977 | | 19,426 | | 19,007 |
| Cost, dollars, per barrel | | | 4.025 | | 3.96 | | 3.99 | | 3.95 | | 3.93 | | 3.96 |
| **CREDIT:** | | | | | | | | | | | | | |
| 10-lb-RVP gasoline, per barrel | $4.62 | | 23,200 | | 22,500 | | 21,600 | | 23,354 | | 22,855 | | 22,181 |
| 10-lb-RVP gasoline, per barrel | $5.04 | | 25,324 | | 24,515 | | 23,628 | | 25,477 | | 24,933 | | 24,197 |
| Earnings at $4.62 per barrel | | | 2,973 | | 3,222 | | 2,909 | | 3,377 | | 3,429 | | 3,174 |
| Earnings at $5.04 per barrel | | | 5,079 | | 5,237 | | 4,937 | | 5,500 | | 5,507 | | 5,190 |

* BPCD—barrels per calendar day. † ASTM D 908—(research method). ‡ FOE—fuel-oil equivalent.

gallon. It is apparent that maximum earnings are obtained from the narrower-boiling heavy charge stock reformed to a moderate octane number. Changing the price of gasoline will affect the position of the curves so far as daily earnings are concerned, but will not change their position relative to one another.

Ordinarily a finished total gasoline of approximately 86 octane number would be adequate, especially if the total refinery gasoline pool includes additional catalytically cracked gasoline and perhaps polymer gasoline. However, in the face of rising octane demand, at some future time it may be necessary to increase the octane number of the total reformed gasoline. The economics of this case are shown in Figure 5, in which the octane-number level of the finished gasoline is 92. Here, again, the cost of producing gasoline is plotted against the clear octane-number reformate. Only two curves are shown, for the reason that it is not possible, without exceeding a limit of 3.0 ml TEL per gallon, to reach 92 octane number when the 300-400 F. stock is reformed. Referring to Figure 2, it will be noted that, even at 95 clear octane number for reformate, the octane number of the 10-pound-RVP finished gasoline with 3 ml TEL per gallon produced from the 300-400 F. fraction is only 91.5. It can be shown that, even at a severity of 100 clear octane number, it is not possible to reach the 92 level with this stock because the destruction of charge stock counterbalances the increase in octane number of the reformate. From Figure 5 it is again apparent that the minimum cost is incurred by reforming of the highest-boiling, i.e., lowest-octane, charge stock with which the necessary octane rating can be achieved. In this particular case the minimum cost of 92-octane-number gasoline is $3.93 per barrel when a 250-400 F. stock is reformed to an 89 to 90 clear octane number. This gasoline contains approximately two ml TEL per gallon. When the 205-400 F. material is reformed, a minimum cost of $3.96 per barrel is obtained when the reforming severity gives a reformate with an 85 clear octane number and the finished gasoline contains 1.4 ml TEL per gallon. In the case where a different TEL content is imposed, it would be necessary either to increase reforming severity or to reform a wider boiling-range charge stock. For example, if the maximum permissible TEL content were 1.5 ml per gallon, then a 92 octane number could be reached by reforming the 250-400 F. material to 95 clear octane number or the 205-400 F. charge stock to 85 clear octane number. In either instance the cost would be approximately $3.96 per barrel. Faced with this choice, the reasonable selection would probably be to install the larger capacity so as to handle the wide boiling-range material. The economics of producing gasoline with a 92 octane number can also be shown on the basis of earnings, rather than cost. This is illustrated in Figure 6. Here gasoline has been valued at both 11 and 12 cents per gallon in order to show the magnitude of the difference. Again it is evident that maximum earnings are obtained by reforming the narrower boiling-range material. Maximum earnings for the 250-400 F. charge occur at a clear octane number of about 89, whereas maximum earnings for the 205-400 F. cut are obtained at the 83 to 85 clear octane-number level.

This case confirms the previous conclusion that the octane number for a given finished gasoline can be reached most economically by reforming the lowest octane-number component possible. It also illustrates the fact that, as the octane demand is increased or the permissible TEL content decreased, the Houdriformer charge boiling range must be increased to include some lower-boiling higher octane-number components. A corollary advantage in reforming the narrowest-boiling stock is the fact that, for a fixed quantity of total straight-run naphtha, this represents the least investment cost.

It is evident from this study that there are many combinations of charge-stock boiling range and reforming severity with which it is physically possible to attain a desired finished gasoline octane-number level. Only through an economic study, however, is it possible to determine the optimum combination. It has been shown that it is most economical to reform the lowest-octane, i.e., highest-boiling, fraction of naphtha with which it is possible to reach the desired octane number. Not only does this represent the lowest total cost and highest earnings, but also the minimum capital cost. The factor which is most likely to compel lowering of the charge-stock initial boiling point is a higher octane-number demand or a limitation on the permissible quantity of tetraethyllead.

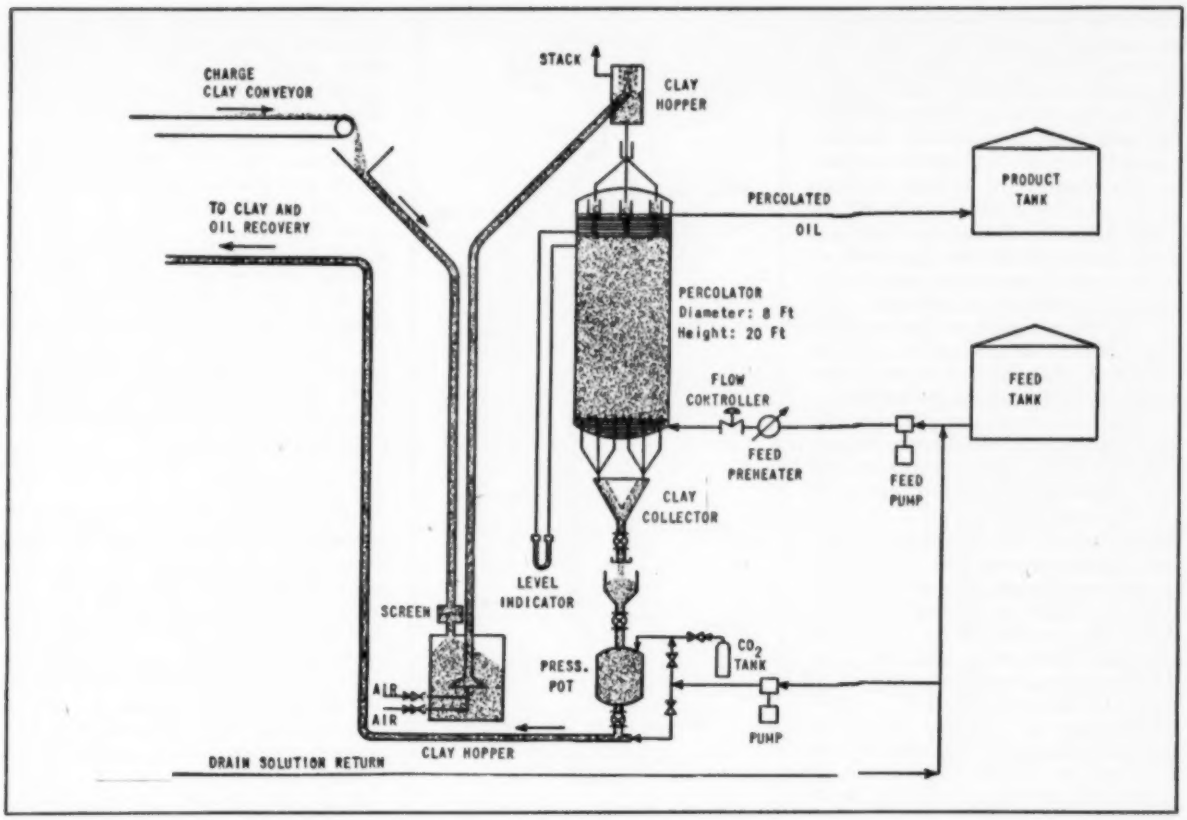



Figure 1. This 500-bpd pilot plant proved operability and efficiency of the process.

# TCP Process Offers These Advantages

- **Lower investment cost than conventional static-bed percolation**
- **Lower operating costs than hot contacting**

**L. P. Evans, K. E. Magin, J. I. Savoca and H. W. Shea,**
Socony-Vacuum Research and Development Laboratories
Paulsboro, N. J.

THE DEVELOPMENT of the Thermofor continuous percolation (TCP) process provides the refiner with a modern, economical method for decolorizing lubricating oils and waxes. The process involves oil decolorizing and clay washing in a continuous counterflow system, clay drying, and regeneration in a Thermofor clay-burning klin. Conventional percolation clays are employed, and no naphtha dilution is necessary on heavy stocks. The essential features of the process have been tested in pilot-scale equipment and proved in a 500-barrel-per-day demonstration plant. The process has been engineered for commercial plants with a capacity up to 8000 barrels per day.

Performance data have been obtained on a variety of stocks. Product yields, in barrels per ton of clay circulated, are about double those from conventional percolation at comparable quality levels. Oil recovery is higher because of efficient washing of spent clay.

The TCP process has a substantially lower investment cost than conventional static-bed percolation, and has a distinct advantage over hot contacting because of lower operating costs. The first commercial TCP plant is nearing completion; a second is under contract; and others are under consideration.

## Background

Lubricating oils are generally decolorized by one of two methods: percolating through static beds of granular clays such as fullers earth or bauxite, or hot contacting with powdered activated clays. Most of the new decolorizing plants installed in this country in recent years have been of the hot-contact type because of the lower capital investment required. On the other hand, the hot-contact process involves higher clay consumption, greater oil loss, and a clay-disposal problem.

In 1939 Socony-Vacuum introduced an improved method for regenerating percolation clays. This was the Thermofor clay-burning kiln[1,2] which was developed at the Socony-Vacuum Research and Development Laboratories, Paulsboro, N. J., and was subsequently installed by several oil companies. The use of this kiln more than doubled the life of clays over previous methods of regeneration as a result of better temperature control. Despite the attendant reduction in operating cost, the overall economy of the percolation process was not sufficiently improved to overcome the lower investment cost of the hot-contact process.

With the Thermofor clay-burning kiln as a "point of departure," Socony pursued development work on the other elements of the percolation process. The technique of continuous countercurrent flow of granular solids and liquids was explored and applied to the percolation and clay-washing steps. A simple, continuous method of drying the washed clay also was developed. These were integrated into the Thermofor continuous percolation process, with marked reduction in both investment and operating costs. The process is designed to operate on conventional percolation clays in the 10 to 60-mesh size range, including bauxite and fullers earth.

This is a brief review of the development work on the TCP process, which extended through operation of a 500-bbl-per-day pilot plant, and describes in some detail the commercial process design. Performance data on typical lubricating-oil stocks are included. Also presented are economic comparisons of TCP with hot contacting and static percolation.

## A. Laboratory-Scale Studies

The initial laboratory studies on the TCP process were designed to establish practical conditions for percolating oil up through a descending column of clay, the clay being fed continuously at the top and withdrawn at the bottom. Two types of equipment were employed for this work.

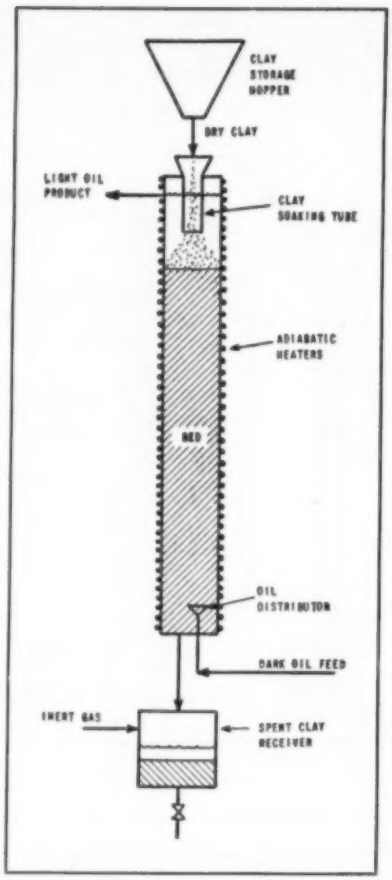



Figure 2. Laboratory continuous percolation tower.

The first type, used to study major process variables, consisted of several adiabatically heated columns ranging up to 6 inches in diameter and 25 feet in height (Figure 2). The second type comprised large-scale models in which the flow characteristics of the liquid and solids streams could be studied to develop data for commercial design (Figure 3). A pilot unit was also built to study the clay-drying operation.

The unfiltered oils used in this work included both solvent-refined and acid-treated lubricating-oil stocks as well as waxes. These stocks were typical of those processed in the conventional percolation plant in Socony-Vacuum's Paulsboro refinery. Properties of these stocks are given in Table 1.

The major process variables studied in the percolation step were: oil rate, column height, and clay size. In all cases clay rate was adjusted to produce specification color. Parallel studies were made of the naphtha-washing step. Performance data were obtained on both fullers earth and bauxite. In order to appraise the results of this investigation, comparative data were developed for static-bed percolation in both plant and laboratory units.

### *Percolation Step*

Oil rate: As oil rate through the percolation column is increased, a rate is reached above which the clay bed expands markedly. For efficient decolorization, oil rate should be kept below this point, where the bed is in compact form. This critical point is a function chiefly of the viscosity of the oil stream, with density and size of clay a minor factor. By adjusting oil-stream viscosity to five centipoises or lower, oil-throughput rates of 10 to 20 barrels per day per square foot of column can be obtained. This adjustment can be made entirely by temperature, thus eliminating the need for naphtha dilution, even on heavy stocks. Temperatures corresponding to a viscosity of five centipoises range from about 125 F. for transformer oils to 350 F. for heavy residual stocks.

Bed depth: When operation proceeds at the above throughput rates, the yield of decolorized oil increases steadily as bed depth is increased up to about 10 feet. Beyond this point yield improves slightly and levels off at a bed depth of about 20 feet.

Yields: When operation proceeds within the prescribed range of oil rate and bed depth, continuous countercurrent percolation gives about 10 percent higher yields of decolorized oil (barrels per ton of clay throughput) than laboratory static-bed percolation. (As pointed out later herein, the yield advantage is much greater on commercial-scale operations.) Experimental data relating yield, oil rate, and bed depth are shown in Figure 4.

Product quality: Lubricating-oil products prepared by continuous percolation at higher temperature without naphtha dilution are comparable in quality to those from conventional percolation with naphtha dilution. This is shown by the data in Table 2.

Microwaxes, and transformer and

**TABLE 1**

**Typical Properties of Unfiltered Lubricating Oils Used in Laboratory TCP Studies**

| STOCK TYPE: | Solvent-Treated Mid Continent Bright Stock | SAE 30 Blend of Solvent-Refined Distillate and Bright Stock | SAE 30 Blend of Acid-Refined Distillate and Bright Stock | Acid-Treated Naphthenic Heavy Distillate | Solvent-Treated Mid Continent Residuum | Solvent-Refined Naphthenic Distillate |
|---|---|---|---|---|---|---|
| Gravity, degrees API at 60 F | 27.1 | 29.4 | 26.0 | 20.5 | 26.5 | 25.2 |
| Flash Point, Fahrenheit | 495 | 435 | 445 | 535 | 570 | 435 |
| Viscosity (Saybolt Universal), Sec: | | | | | | |
| At 100 F | 1,287 | 464 | 622 | 5,180 | 2,370 | 515 |
| At 210 F | 103 | 62 | 67.5 | 173 | 142 | 58.1 |
| Viscosity Index | 94 | 99 | 88 | 53 | 96 | 62 |
| Color, ASTM | >8 | 2½— | 7— | >8 | 8— | 2½— |
| Neutralization No. | 0.01 | Nil | Nil | 5.72 | .... | .... |
| Carbon Residue (Ramsbottom), percent by Weight | 0.4 | 0.2 | 0.4 | 0.9 | .... | .... |

turbine oils, also can be produced in satisfactory quality without the special precautions required for these stocks in conventional percolation. These products are generally sensitive with respect to properties other than color (such as odor, cast, and resistivity). For example, in the case of microwaxes this usually requires naphtha dilution and clay segregation. With transformer oils it is common practice to use fresh burned clay entirely—a very costly item. Data presented in Table 3 shows that, with continuous percolation, it is possible to make both types of products using only "equilibrium" clay and no dilution.

Flow studies: The flow studies specific to the percolation step concerned the problem of continuously introducing and withdrawing the clay and oil streams in the percolation column. The equipment sketched in Figure 3 is typical of various flow models used in this study, the flow being visible through transparent walls in the model. Following are some general observations from this study which form the basis for the process design.

(a) The top of the percolation column should be designed to insure uniform distribution of the fresh clay across the column with no carryover of clay, either by entrainment or flotation. Entrainment of fine clay particles is minimized by providing a settling zone above the clay bed. Flotation of coarser particles is prevented by allowing the fresh (dry) clay stream to drop through confined quiescent sections in the upper half of this settling zone. Complete de-aeration of the feed clay also takes place in this zone. The oil-soaked clay spreads rapidly across the bed due to the upward oil velocity, which permits wide spacing of the clay inlet pipes.

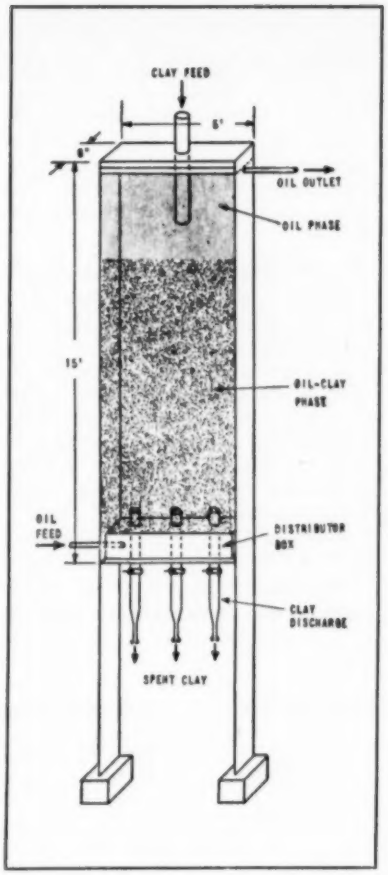



Figure 3. Pilot percolation tower used for flow studies.

(b) The bottom of the column should be equipped with manifold systems for uniform oil distribution and clay withdrawal. The clay drawoff system should operate with minimum downflow of oil with the spent clay. A multi-pipe arrangement is practical for this purpose. Suitable mechanical means can be provided to control the rate of clay discharge from these pipes. Such a system permits withdrawal of spent clay in a slurry containing not more than 1 volume of oil per volume of clay.

Naphtha washing: The naphtha-washing step is designed to recover the oil from the spent-clay slurry received directly from the percolator. This step involves continuous countercurrent flow of naphtha and clay in a column similar in general design to the percolator. A column height of 10 feet with an enlarged settling zone at the top, is adequate for the wash tower. A paraffinic naphtha of intermediate (240 to 340 F.) boiling range is preferred for this operation.

The washing efficiency obtained with continuous countercurrent operation is better than with the static-bed process. This is shown by laboratory test data in Table 4. These tests were made on a spent clay from percolating a paraffinic residual oil. The spent-clay mixture contained about 50 percent of oil plus color bodies by weight. The static washing test included the usual steaming operation at the end of the washing cycle.

It will be noted that continuous washing gave very efficient recovery of oil with little color-body removal from the clay. This oil can be recycled to the percolator with no penalty in overall yield. The static operation gave 23 percent less recovery of recycle oil, and a corresponding amount of "steamings," the latter is a very dark oil suitable only for fuel-oil blending and, therefore, constitutes an actual net loss of lubricating oil product. This proportion of the total oil in the clay degraded to "steamings" in

**TABLE 2**

**Properties of Lubricating Oils Decolorized by Continuous (TCP) and Fixed-Bed Percolation**

| TYPE OF FINISHED STOCK | Solvent-treated Mid Continent Bright Stock | | SAE 30 Blend of Solvent-refined Distillate and Bright Stock | | SAE 30 Blend of Acid-refined Distillate and Bright Stock | | Acid-treated Naphthenic Heavy Distillate | | Solvent-treated Mid Continent Residuum | | Solvent-refined Naphthenic Distillate | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Method of Percolation** | **Static-Bed** | **Continuous** | **Static-Bed** | **Continuous** | **Static-Bed** | **Continuous** | **Static-Bed** | **Continuous** | **Static-Bed** | **Continuous** | **Static-Bed** | **Continuous** |
| **Processing Data:** | | | | | | | | | | | | |
| Operating temperature, fahrenheit | 125 | 300 | 120 | 260 | 150 | 270 | 120 | 370 | 120 | 350 | 150 | 250 |
| Bed height, feet | 25 | 10 | 25 | 10 | 25 | 10 | 25 | 10 | 25 | 10 | 25 | 10 |
| Product rate, bbl. per day, per sq. ft. | ... | 8.6 | ... | 17.1 | ... | 17.1 | ... | 8.6 | ... | 8.6 | ... | 8.6 |
| Naphtha dilution normally required | Yes | No | No | No | No | No | Yes | No | Yes | No | No | No |
| **Properties of Product Oils:** | | | | | | | | | | | | |
| Gravity, degree API at 60 F | 27.7 | 27.3 | 29.5 | 29.6 | 26.1 | 26.0 | 21.5 | 21.7 | 26.6 | 26.3 | 25.3 | 25.3 |
| Flash point (Cleveland open cup), F | 480 | 495 | 440 | 425 | 440 | 425 | 530 | 525 | 565 | 585 | 430 | 435 |
| Viscosity (Saybolt Universal), sec: | | | | | | | | | | | | |
| At 100 F | 1,170 | 1,240 | 441 | 449 | 597 | 612 | 3,870 | 3,370 | 2,400 | 2,700 | 541 | 525 |
| At 210 F | 95.6 | 98.2 | 61 | 61.4 | 66 | 67 | 148 | 141 | 146 | 157 | 59 | 58.7 |
| Viscosity index | 95 | 95 | 101 | 100 | ... | ... | 55 | 54 | 95 | 95 | 61 | 62 |
| Color, ASTM | 6+ | 6+ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | 6— | 6— | 8 | 7+ | 7+ | 7+ | $2\frac{1}{2}$— | $2\frac{1}{2}$— |
| Neutralization No. | Nil | Nil | Nil | Nil | 0.01 | 0.01 | 0.38 | 0.04 | ... | ... | ... | ... |
| Carbon residue (Ramsbottom), percent by weight | ... | 0.2 | 0.1 | 0.2 | 0.5 | 0.6 | ... | 0.4 | ... | ... | ... | ... |
| **Yields: Barrels of Oil per Ton of Clay:** | | | | | | | | | | | | |
| Laboratory: continuous | 39 | | 14 | | 120 | | 6.9 | | 60 | | 40 | |
| Plant: static-bed | 22 | | 6 | | 49 | | 5.6 | | 27 | | 24 | |
| Laboratory: static-bed | 35 | | 14 | | 79 | | ... | | 49 | | 32 | |
| Ratio: continuous to laboratory static | 1.11 | | 1.00 | | 1.52 | | ... | | 1.23 | | 1.25 | |
| Ratio: continuous to plant static | 1.77 | | 2.34 | | 2.45 | | 1.17 | | 2.22 | | 1.66 | |

the static process appears to be in the range of 15 to 25 percent for all stocks. The total oil loss per ton of clay handled is thus about two to three times as high for static percolation as for continuous percolation.

Clay drying: This step is required to effect complete removal of the naphtha carried with the spent clay from the washing step. The experimental equipment used for this study (Figure 5) comprises a simple tank equipped with steam-heating coils. The wet clay is charged continuously into the tank, and it disperses into a bed which is agitated by a small amount of steam or flue gas entering at the bottom. Sufficient heat is supplied by the coils to flash off the naphtha and permit continuous withdrawal of dry clay from the top of the bed. Heat transfer rates up to 6000 Btu per hour per square foot of coil surface were found to be practical for this operation, using 160-pound steam in the coils. This unit operated satisfactorily at clay throughput rates up to 10 tons per day.

The clay emerges from the drier moisture-free because of the temperature (350 to 400 F.) in the bed. By contrast, the steamed clay obtained in conventional percolation usually contains 10 to 12 percent moisture. This moisture has a tendency to deactivate the clay.

## B. 500-Bbl-Per-Day Pilot Plant

The promising results obtained in the laboratory-scale investigation led to extensive engineering and economic studies to appraise the commercial potentialities of the process. These studies in turn led to the final phase in the development program, viz., the construction and operation of a 500-barrel-per-day moving-bed pilot plant. This unit was installed at Socony-Vacuum's Paulsboro refinery, adjacent to its conventional percolation plant.

The purpose of this phase of the program was to demonstrate both the operability and efficiency of the process on a substantial scale. It was considered adequate to limit the investigation to the percolation step, inasmuch as the washing step in the continuous process is similar in principle. The continuous drying step was also omitted in this setup because of the scale of the pilot plant previously described and the simplicity of the operation.

### *Equipment*

The experimental section of the unit consisted of a percolation tower about 8 feet in diameter and 20 feet high. Auxiliary equipment was provided for supplying regenerated clay and charge-oil streams from the refinery filter plant and returning the spent-clay and product streams to the plant. The experimental setup is shown in the flow diagram in Figure 1.

### *Charge Stocks*

The charge stocks used were those available in sufficient quantity in the refinery schedule during the test period.

**TABLE 3**

**Quality of Microwax and Transformer Oil Produced by TCP Processing**

| Product: | Microwax | | Transformer Oil | |
|---|---|---|---|---|
| | Desired Properties | TCP Product | Desired Properties | TCP Product |
| Yield, barrels of oil per ton of clay* | .... | 4.1 | .... | 4.5.1 |
| Percolation temperature, Fahrenheit | .... | 300 | .... | 130 |
| **Product Properties:** | | | | |
| Gravity, Degree API at 60 F. | 36.0 | 34.6 | 28.4 | 28.5 |
| Viscosity (Saybolt Universal), at 210 F., sec. | 75 | 76 | 33.5 | 33.6 |
| Color, ASTM | 2½ | 2 | 1 Max. | 1— |
| Needle Penetration at 77 F | 22/32 | 25 | .... | .... |
| Cast | .... | OK | .... | .... |
| Odor | .... | Satisfactory | .... | .... |
| General Electric Bomb Sludge, percent by Weight | .... | .... | 0.025 Max. | 0.017 |
| Sludge Accumulation, percent by Weight per 14 Days | .... | .... | 0.18 | 0.17 |
| Resistivity at 185 F, ohms per centimeter times $10^{12}$ | .... | .... | 500 | 2,200 |

* TCP percolations conducted on equilibrium clay.

**TABLE 4**

**Oil Recovery in Naphtha-Washing Step—Continuous vs. Static-Bed Operation**

(Charge Oil: Solvent-treated Mid Continent Residuum; ASTM Color, 7—Clay: Equilibrium 30- to 60-Mesh Fullers Earth)

| | Continuous | | Static | |
|---|---|---|---|---|
| Volume of Wash Naphtha, per vol. of clay* | 1.0 | .. | 1.0 | .. |
| | Percent | ASTM Color | Percent | ASTM Color |
| Recovered Oil* | 88 | 8— | 65 | 8 |
| Steamings | .. | .. | 21 | Very dark |
| Color Bodies and Non-recoverable Oil | 12 | .. | 14 | .. |
| | 100 | .. | 100 | .. |

* Drained clay from either process, as charged to washing, retained oil about equal to the weight of the dry clay.

**TABLE 5**

**Operating Data on Three Typical Stocks Processed in 500-Barrel-Per-Day Pilot Plant**

| STOCK | SAE 30 Mid Continent Distillate Viscosity (Saybolt Universal) at 210 F: 65 Sec. | Solvent-treated Mid Continent Bright Stock Viscosity (Saybolt Universal) at 210 F: 145 Sec. | Solvent-treated Mid Continent Bright Stock Viscosity (Saybolt Universal) at 210 F: 95 Sec. |
|---|---|---|---|
| Percent by volume of naphtha in charge to percolator | 35 | 50 | 50 |
| **CLAY:** | 30 to 60-Mesh Fullers Earth "Equilibrium" | 30 to 60-Mesh Fullers Earth Fresh Burned | 15 to 30-Mesh Fullers Earth No. 1—Burned |
| Clay bed height, feet | 16.5 | 16.5 | 16.5 |
| Product rate, barrel per day | 388 | 837 | 630 |
| Product rate, barrel per day, per sq. ft. | 7.7 | 16.6 | 12.5 |
| Color of charge, ASTM | 8 | 7— | 7— |
| Color of product, ASTM | 5— | 5 | 5— |
| Oil-inlet pressure, psig. | 10.5 | 11.9 | 24.0 |
| Operating temperature, fahrenheit | 103 | 107 | 77 |
| Viscosity of oil stream, centipoises | 4.0 | 4.3 | 5.2 |
| **YIELDS:** Barrels of Oil per Ton of Clay | | | |
| TCP | 53 | 193 | 87 |
| Laboratory static | 49 | 156 | 75 |
| Plant static | 14 | 64 | 39 |
| **Ratio of Yields:** | | | |
| TCP to laboratory static | 1.08 | 1.24 | 1.16 |
| TCP to plant static | 3.7 | 3.0 | 2.3 |

**TABLE 6**

**Economics of TCP, Hot-Contacting, and Static-Bed Percolation for Finishing 3000 Barrels Per Day of Mid Continent Lubricating Oils and Waxes**

| INVESTMENT | Thermofor Continuous Percolation | Hot Contacting | Static-Bed Percolation | TCP Minus Hot Contacting |
|---|---|---|---|---|
| **Investment:** | | | | |
| Clay regeneration | $300,000 | $ | $ 500,000 | ..... |
| Decolorizing and naphtha recov. | 650,000 | 780,000 | 1,980,000 | ..... |
| Clay inventory | 1,200 | 14,000 | 35,000 | ..... |
| Total* | $951,200 | $794,000 | $2,515,000 | $157,200 |
| **Operating Costs, Dollars per Day:** | | | | |
| Labor | 96 | 96 | 144 | ..... |
| Maintenance: | | | | |
| Labor (3 percent) | 78 | 64 | 204 | ..... |
| Material (2 percent) | 52 | 43 | 136 | ..... |
| Labor burden (25 percent) | 44 | 40 | 88 | ..... |
| Fuel | 110 | 75 | 165 | ..... |
| Clay makeup and supplies | 40 | 720 | 140 | ..... |
| Lubricating-oil loss | 252 | 504† | 382 | ..... |
| Taxes and insurance (1 percent) | 26 | 22 | 69 | ..... |
| Total, dollars per day | 698 | 1,564 | 1,328 | —866 |
| Differential earnings | ..... | ..... | ..... | 866 |
| Depreciation at 8 percent per year | ..... | ..... | ..... | 34 |
| Taxable income | ..... | ..... | ..... | 832 |
| Federal income tax at 50 percent | ..... | ..... | ..... | 416 |
| Net earnings | ..... | ..... | ..... | 450 |
| Payout, years | ..... | ..... | ..... | 0.96 |

* In any completely new installation there would be some off-site expenditures required in addition to these totals. However, it has been assumed that these off-site expenditures would be substantially the same for the three cases considered. Furthermore, in the case of a replacement project, these off-site expenditures would obviously be very small.

† Loss would be estimated at $882 for a plant with Sweetland instead of precoat filters. Total would then be $1,920 per day.

They included two bright stocks and one heavy neutral stock. For convenience, these stocks were percolated in naphtha solution, paralleling the filter-plant operation. Throughput rates ranged from 225 to 1250 barrels per day of solution. Individual runs extended over 10-day periods. Laboratory static percolations were made using the same oil and clay to check the efficiency of the 500-barrel-per-day runs. Pertinent operating and yield data from typical runs on these stocks are shown in Table 5.

*Yields*

As noted in Table 5, the product-oil yields (barrels per ton of clay) from the 500-barrel-per-day unit were about 10 percent higher than from laboratory static percolation. This checks the efficiency found in laboratory continuous percolation, and demonstrates that no efficiency is lost in enlarging the scale of the continuous process. The commercial static percolation yields, however, are lower by a factor of two to three. The quality of the products from the continuous operations was identical to that of the refinery products in all respects.

*Performance*

The 500-barrel-per-day unit operated satisfactorily as designed. Such essential factors as fines carryover, oil and clay distribution, and spent-clay withdrawal were carefully checked. On the basis of this work, continuous percolation towers of any size can be designed with confidence.

## Process and Mechanical Design Of Commercial Units

A TCP unit may be divided into a percolation section, a naphtha-wash section, and a regeneration section. The percolation section includes a decolorizing tower and its auxiliary equipment for feeding and withdrawing oil and clay. The naphtha-wash section includes a wash tower, with its auxiliary equipment, and a clay drier. The regeneration section consists of a Thermofor clay-burning kiln, and the elevators and conveyors for transporting the clay.

A schematic flow diagram for a commercial TCP unit is shown in Figure 6. The process steps will be described using this diagram as a reference.

*Oil Percolation*

The oil to be decolorized is preheated and introduced into the bottom of the percolation tower through a multi-nozzle distributor. The product oil is taken overhead through a blotter press to remove traces of entrained clay; it is cooled; and it is then sent to storage.

Regenerated clay from the kiln is fed into the top of the percolator and distributed over the cross-section of the tower through a number of feed legs. The clay falls through the oil in the settling zone, and merges with the clay bed. The rate of clay feed is adjusted to give the desired product color. The spent clay is withdrawn from the bottom of the percolator through a multi-pipe drawoff system. The drawoff rate is controlled automatically to maintain a constant bed level in the percolator. About an equal volume of oil is discharged from the tower with the spent clay.

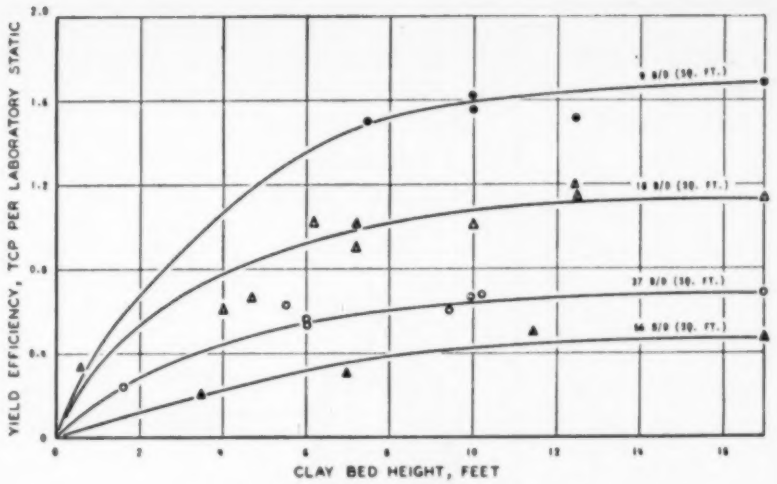



Figure 4. Effect of oil rate and bed depth on yield.

*Clay Washing for Oil Recovery*

The spent-clay stream from the percolator drops into the top of the wash tower, and the spent clay is washed countercurrently with naphtha in an operation similar to the percolation step. The naphtha-oil solution taken overhead is charged to a stripper where the naphtha and oil are separated. Stripped oil is recycled to the percolator with the fresh feed, and the naphtha is returned to the wash system. A portion of the wash-tower overhead stream may be cooled and recycled, if necessary, to prevent boiling of naphtha by contact with the hot oil-clay slurry in the top of the wash tower. The control of bed level in the wash tower is similar to that in the percolator.

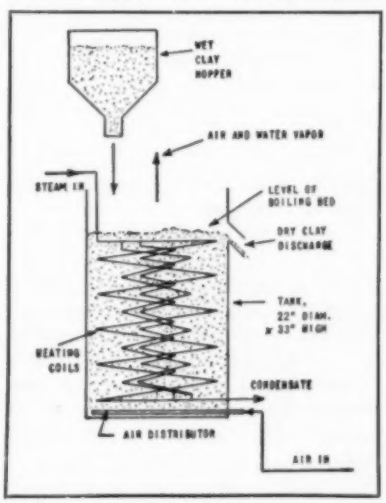



Figure 5. Clay-drier pilot plant.

*Drying and Regeneration of Spent Clay*

The washed clay, containing some naphtha, enters a drier of the type previously described, from which dry clay free of naphtha is withdrawn continuously. The naphtha vapor from this drier is condensed and recycled to the washing system. The dry spent clay is regenerated in a conventional Thermofor clay-burning kiln.

*Block Operation*

The process has good flexibility for processing several stocks in the same unit. Pilot-plant experience demonstrates that, by proper scheduling of stocks, it is possible in most cases to eliminate slop-oil cuts during changeover periods. In some cases the percolation and washing sections may be divided into two or more small units rather than one large one. Such division is desirable when a large variety of stocks is processed, particularly special stocks such as waxes which involve relatively small volumes or which are extremely sensitive to contamination. In such a plant a common drier and kiln would still be used.

## Economics of the TCP Process

The economics presented in Table 6 are based upon extensive plant experience with static-bed percolation and hot contacting, and upon pilot-plant evaluations and semi-commercial plant

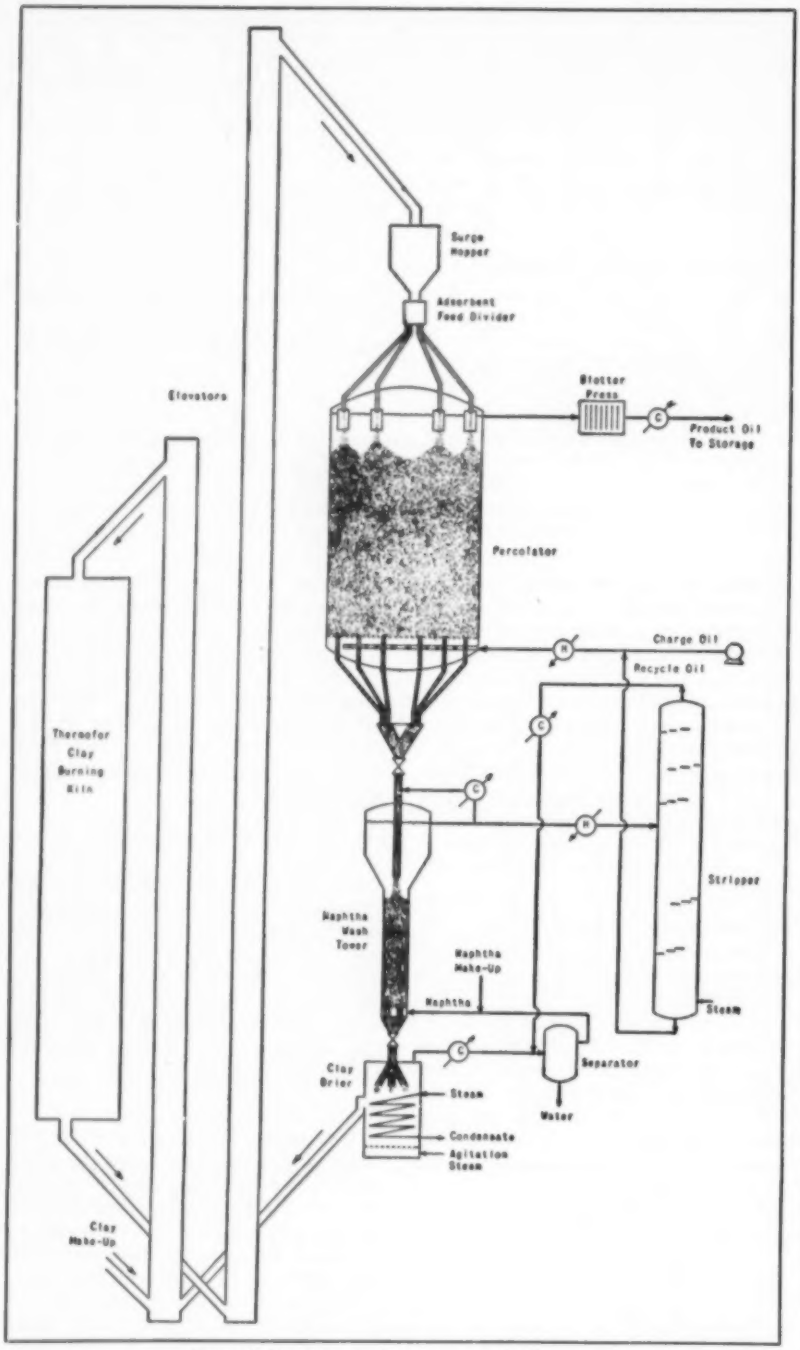



Figure 6. Flow diagram for a commercial TCP unit.

operating experience with the TCP process. These economics, obviously, will vary from location to location, but they are believed to be representative and illustrative of what can be expected. As explained in Table 6, the total investment costs indicated for the three processes do not include such items as tankage, utilities facilities, and certain other off-site requirements for a completely new installation which are assumed to be the same for the three cases presented. This assumption would be substantially valid also in the case of a replacement project wherein a new TCP unit would be installed and an existing hot-contacting plant retired. The operating costs tabulated include all of the costs which would be variable from process to process, but they do not include items of direct operating costs, such as laboratory expense, pumping and gaging, clerical, technical and engineering expense, and other small expenses which are assumed to be common to the three cases.

The economic comparison of the TCP, hot-contacting, and static-bed processes for decolorizing 3000 barrels per day of Mid Continent lubricating oils and waxes presented in Table 6 indicates that the initial investment required for a TCP plant is about 20 percent higher than the cost of a modern hot-contacting unit with a precoat filter. Nevertheless, the incremental investment of approximately $150,000 will be paid out in less than one year after taxes by the reduction in operating costs and lubricating-oil loss.

The TCP process shows a very large economic advantage over static-bed percolation because of the very high investment requirement and the higher operating cost for the latter.

Inasmuch as the large majority of lubricating-oil manufacturers employ hot contacting, the economics of installing a new TCP unit in place of an existing hot-contacting unit will be of interest, especially in the case where the hot-contacting unit does not embody the modern precoat filtration or may otherwise be obsolescent. In this case an economic computation similar to that shown on Table 6 indicates that a TCP unit installed in place of an existing hot-contacting plant can, under some conditions, be paid out in less than four years by virtue of reduced operating costs and increased lubricating-oil recovery.

Similarly, the conversion of even a modern static-bed percolation unit to continuous percolation will pay out in less than four years. Shorter payouts are indicated for the conversion of older, less efficient static-bed operations.

## Commercial Program

As of this writing, a 2100-barrel-per-day TCP unit is being built at Coryton, England, and a 3000-barrel-per-day plant has been licensed for erection in Holland. The Lummus Company was awarded the contracts for these plants. Numerous other TCP projects are under consideration.


REFERENCES

[1] T. P. Simpson, E. S. Nicholls, and J. W. Payne, "Recent Advancements and Application of the Thermofor Kiln in the Petroleum Industry," *Trans. Am. Inst. Chem. Engrs.* **36** [6] 841 (1940).

[2] H. C. Myers and R. M. Owen, "Economic Survey of Thermofor Installations in Socony-Vacuum Lubricating-Oil Refineries," *Oil Gas J.* **44** [13] 93-7 (1945).

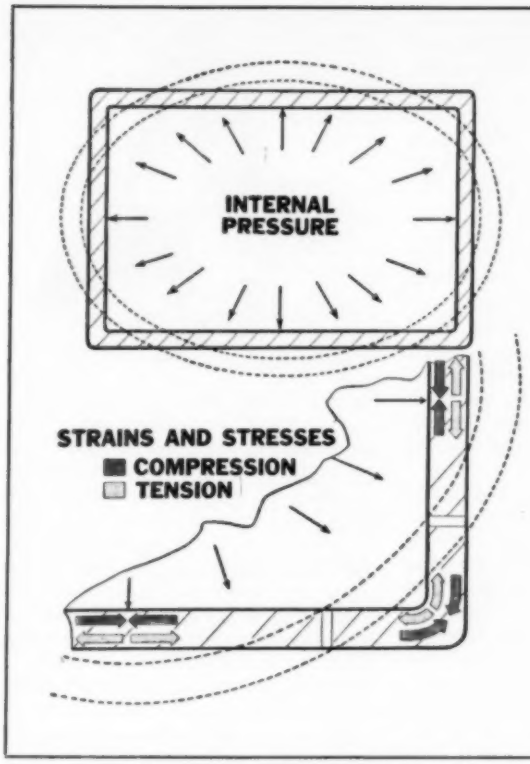



Figure 1. Effect of explosive forces.

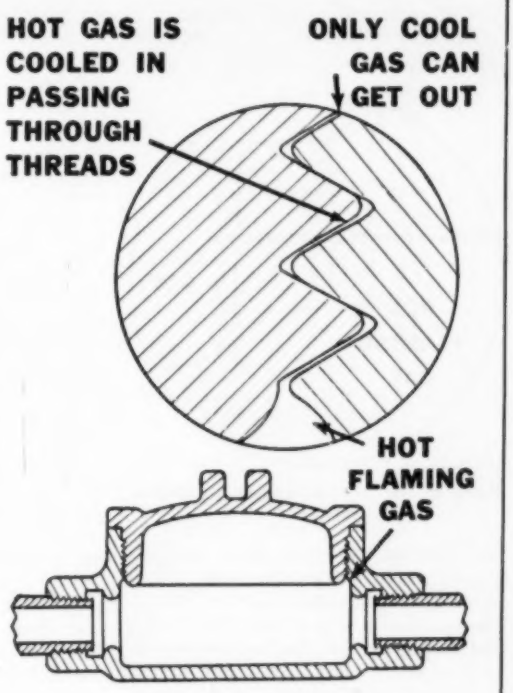



Figure 2. Joint strength improved by threading.

# Explosion-Proof Equipment Is Here to Stay

**These are practical hints on the design, application, operation and maintenance of this vital component**

**R. P. Northup,**
Crouse-Hinds Company,
Syracuse, N. Y.

AS A MANUFACTURER, our problem is design of explosion-proof equipment. Your problem in the petroleum industry is application. Your knowledge of equipment is frequently more important than ours because you must know about design to be able to select the devices which will do the job safely with a minimum of maintenance.

Every engineer who designs an electrical installation faces many problems. Primarily, he cannot compromise with safety. He must use the right equipment to do the job and avoid costly makeshifts. With few exceptions, there is no need to take chances. Explosion-proof equipment is available to make a complete and safe electrical installation. Three important considerations are:

1) Responsibility.
2) Conditions of operation:
   a) Maintenance procedures.
   b) Corrosive conditions.
3) Cost of special arrangements of equipment compared to cost of explosion-proof equipment.

Responsibility of all concerned is clearly defined in Sect. 5002 of *The National Electrical Code*. The first paragraph reads as follows:

*"Special precaution:* The intent of this article is to require a form of construction of equipment and of installation that will insure safe performance under conditions of proper use and maintenance. It, therefore, is assumed that inspection authorities and users will exercise more than ordinary care with regard to installation and maintenance."

That paragraph is important: Equal responsibility for safety of personnel and protection of property is assigned to the manufacturer of equipment, the installer, the inspector, and the user.

Design of explosion-proof equipment is guided by general rules established by the Underwriters' Laboratories, Inc. and *The National Electrical Code* requirements. Both of these rules are minimum standards, and much latitude is permitted. The designer uses several methods to make any item safe for various conditions of operation.

Basically, explosion-proof equipment must provide three things:

- Strength.
- Joints which will not pass flame or hot gases.

MAINTENANCE / OPERATION

Original presentation as "Design and Application of Explosion-Proof Equipment" was at the 18th Mid-Year meeting of the API Division of Refining, New York, May 11.

• Cool operation to prevent ignition of surrounding atmosphere.

The code defines an explosion-proof case as one which is capable of with-

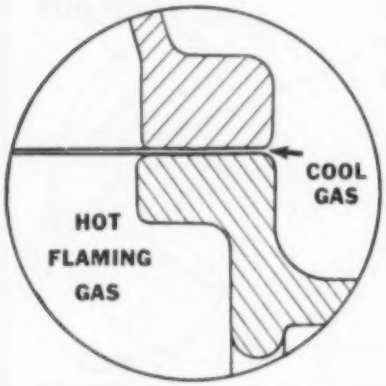



Figure 3. Flat joint produced by accurate machining.

standing an explosion of a specified gas or vapor which may occur within it, and of preventing the ignition of the specified gas or vapor surrounding the enclosure by sparks, flashes, or explosions of the gas or vapor within.

Figure 1 illustrates this requirement. When it occurs inside a rectangular enclosure, an explosion exerts pressure in all directions. The enclosure tends to be forced into the shape of an ellipse or, ultimately, into a sphere. Stresses are set up in the corners and on the side walls which are directly opposite each other. We find tension on the inside of each corner, and compression on the outside. Complete reversal of forces causes tension on the outside of the side wall and compression inside.

These forces increase tremendously as the size of the enclosure increases. Explosive pressures exerted on the side walls tend to break the enclosure at the corners. Accordingly, we find that larger rectangular enclosures must have the corners built up to provide the strength necessary to resist this breaking action.

The obvious answer to this problem is to produce designs which will utilize more effectively the strength of the metal. That is why you find many cylindrical or partly spherical explosion-proof fittings. If an enclosure were a perfect sphere, explosive forces occurring within it would create tension in the side walls, and all forces would be exactly balanced. The nature of electrical equipment makes a spherical housing impracticable. However, much can be done to reduce weight and, in turn, reduce installation cost, if cylindrical enclosures are designed or if rectangular enclosures are modified so that they can use elliptical sections.

The next consideration is the design of joints which will not pass flame or hot gases. There are two generally recognized joint constructions.

Figure 2 illustrates a threated joint. Threaded construction of covers and other removable parts is logical. The code specifies that explosion-proof installations shall be wired in rigid conduit with five full threads engaged at couplings and hubs of fittings. The same five-thread engagement produces a safe, flame-arresting joint between a cover and body. Here is how it works:

When an explosion occurs inside the case, the flame and hot gases are forced to the outside. Passing through the threaded joint, the flame and hot gases must travel over the hills and valleys of the thread. In addition, the cover is forced outward from the body, thus locking the threads at the top. Accordingly, the flame must also travel around and around the cover. As a result, the path to the outside is very long.

The threaded joints have many ad vantages. First and foremost, they are not easily damaged. The Underwriters' Laboratories, Inc., says that five full threads engaged make a safe joint for Class I, Groups C and D hazardous areas. On threaded-joint units you will find that there are always six or seven threads. If a cover is dropped and one thread damaged, it is easily corrected with a three-cornered file. One can be assured that, if a cover can be installed in a unit, a safe and flametight joint will result. If a threaded joint cover is left slightly loose, the joint is still safe and flametight. The practice of leaving covers loose on explosion-proof bodies is not recommended because vibration could easily remove the covers.

Figure 3 illustrates the second commonly used explosion-proof joint. It is a flat joint, which is produced by accurate grinding or accurate machining of the surface of the cover and the body. The flat joint works in a manner similar to the threaded joint. The two surfaces are bolted closely together and, as flame and hot gases are forced through the narrow opening, they are cooled by the mass of metal of the body and cover, and only cool gas can get out. Extreme care must be exercised in the use of ground joint equipment to assure that all cover screws are tight and that no foreign matter is introduced between the cover and the body. On typical small explosion-proof devices the Underwriters' Laboratories, Inc., specify a maximum clearance of 0.0015 inch between the body and the cover that is much thinner than a cigarette paper. A small particle of foreign matter between the cover and body will hold the joint open wide enough to pass flame. A loose cover screw will do the same thing. A cover which has been dropped and damaged during installation can also be unsafe.

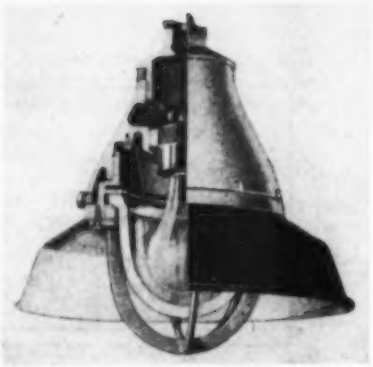


Figure 4. Cutaway of typical lighting fixture.

Figure 4 illustrates a typical explosion-proof lighting fixture. Obviously it is necessary that a device which produces heat in its normal operation must be enclosed in such a manner as to assure that the external surfaces are maintained below the ignition temperature of flammable vapor or gas which may be in the atmosphere. A lighting fixture is a typical heating device. The external temperatures are controlled by extensive radiating surfaces which dissipate the heat of the lamp evenly and protect against temperature concentrations which would be dangerous.

The lighting fixture also gives us an opportunity to review the other requirements. First, we can note the strength of the cast parts and the strength of the glass globe. The explosion-proof, impact-resisting, heat-resisting glassware used in this fixture (Figure 4) is designed to withstand the explosion pressure encountered when an explosion occurs in the lamp chamber. In fact, to meet Underwriters' Laboratories, Inc., requirements of a 4-to-1 factor of safety, this fixture, as well as any other explosion-proof enclosure, must stand a hydrostatic pressure of four times the explosion pressure determined by actual test. The explosion pressure in this typical 150-watt fixture is approximately 80 psi; four times that is 320 psi. There are approximately 16 square inches in the area across the top of the globe, which means that on hydrostatic test there is a force of more than 5000 pounds

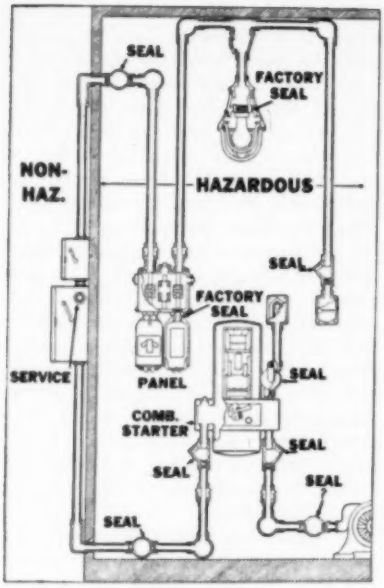



Figure 5. Illustration of the three basic requirements for sealing.

which tends to break the globe out of the globe holder.

The construction of this lighting fixture also shows the use of threaded and ground joints. Threaded joints are used for all metal-to-metal openings, and a factory-assembled ground joint is used between the globe and the globe holder. This is done because it is impractical to thread glassware, and the flat joint is factory-assembled so it will never be necessary to open it in the field. This provides full safety so that the glassware will not become chipped or otherwise damaged during relamping.

The real problem in any explosion-proof installation is to assure that all equipment is as safe as possible when originally installed, and that it is of a type which will maintain the maximum safety throughout the life of the installation. An explosion-proof installation which has been allowed to deteriorate is similar to a lapsed insurance policy. It may be nice to look at, but it has no value when it is needed.

Maintenance procedures are of primary importance in determining the class of equipment necessary for safety. Many items which are entirely safe for use in a clean, well-maintained location, such as a hospital operating room, would have little or no value in a refinery or in the corrosive locations of a chemical plant. Corrosive conditions determine the selection of metals. Under practically all normal operating conditions standard metals furnished by reputable manufacturers are satisfactory if normal maintenance is observed. There are conditions which require special metals so as to provide reasonable protection. For example, in some areas the corrosive fumes will cause aluminum to deteriorate and lose its strength. In other areas aluminum is the only metal which will meet the requirements of the installation.

We strongly recommend the use of threaded-joint explosion-proof equipment. As with any other metal parts which move together, maintenance is required. With threaded joints it is only necessary to keep the threads clean and well lubricated. If this is done, safe operation can be assured with a minimum of maintenance or installation expense. If the operations required to remove a large threaded explosion-proof cover are contrasted with the operations involved in removing a large bolted cover, a realistic idea of the relative cost of installation and maintenance can be obtained.

Several large rectangular explosion-proof enclosures have as many as 40 or 50 bolts to hold the cover in place. To make a safe assembly of the cover and body, each bolt must be tightened evenly and thoroughly. One or more loose bolts can easily permit the passage of flame and cancel out the entire value of the explosion-proof installation.

Ground-joint construction is necessary for certain types of equipment, and for certain sizes and shape of enclosures. Maintenance procedures must be very carefully regulated. Ground-joint devices should always be thoroughly cleaned when the parts are assembled. If corrosion products have accumulated which cannot be removed with light cleaning solvents, the parts should be discarded and replaced. Each bolt which attaches the cover to the body should be tightened evenly, just as one would tighten the head of a motor in an automobile. Approximately equal torque should be applied in tightening all bolts so as to avoid warping the cover.

It is well to apply a film of light oil to both surfaces of the cover and body before these are assembled. Also, each time the cover is removed, this oil should be wiped away in order to remove any dirt which may have collected. Before re-assembly of the cover, clean oil should be applied.

On ground-joint equipment care should be taken to use only the bolts and other parts provided by the manufacturer. In many instances high-strength screws or bolts are used in order to avoid the possibility of stretching under the force of the internal explosion.

Actually an explosion-proof installation is very similar to a conduit installation in ordinary locations. The

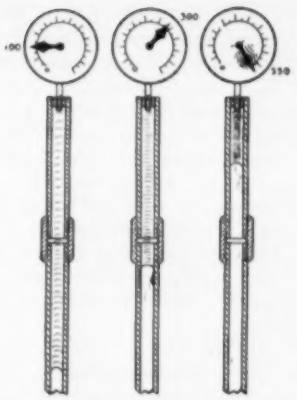


Figure 6. Schematic illustration of pressure buildup in long conduits.

only real difference is the correct selection of explosion-proof equipment, plus one major feature. Section 5015 of the electrical code sets up requirements for sealing. When we recognize that a conduit system provides a passageway for the movement or collection of flammable mixtures of vapor and air, we have one of the major reasons for sealings. The second reason is the necessity of confining explosions to enclosures which are designed to handle them.

There are three basic requirements for sealing which are illustrated in Figure 5. The first is to seal all conduit runs adjacent to and as close as practicable to any enclosure of an arcing, heating, or sparking device of any type. The second requirement is to seal between hazardous and non-hazardous atmospheres. These seals can be located on either side of the partition or other dividing line between the hazardous and non-hazardous atmosphere; but there should be no coupling, union, or other fitting between the seal and the point of exit from the hazardous atmosphere. The sealing fitting must be designed to prevent the entrance of flammable mixtures into the conduit system between the seal and the non-hazardous area.

The third requirement for sealing applies only in conduits which are two inches in size or larger. Here we find that sealing is required adjacent to terminal or connection boxes, such as motor terminals or junctions in which splices are made.

These sealing requirements are logical. The first and greatest hazard in all electrical equipment results from the device which creates an arc due to its normal operation. Therefore, we seal

all conduits entering such a device. The second hazard is a lighting fixture or other heating device, and here we find that the Underwriters' Laboratories standards for construction of the lighting fixture specify a built-in factory seal between the lamp compartment and the wiring chamber. The third hazard, in order of degree, is a terminal or splice connection which may fail because it has become loosened, because it has collected moisture, or because of other common insulation failures.

Requirements for sealing of conduits which are two inches in size or larger are designed to protect against the phenomenon known as "pressure piling." In larger conduits there is a considerable amount of free space between the conductors and the inside walls of the conduit. When the latter becomes filled with a flammable mixture and is ignited at one end, the explosive forces travel through this conduit in successive waves; each wave precompresses the mixture ahead of it, and this results in an explosion of greater force. The only limitation is the friction created by the side walls and the conductors. Figure 6 illustrates schematically the possible buildup of pressure through long conduit runs. Without seals to limit these runs at terminal boxes and similar enclosures, it is entirely possible that pressures would exceed the ability of the enclosures to withstand the force.

Many discussions concern the possibility of installing non-explosion-proof equipment adjacent to hazardous locations, but far enough removed to assure safety. It is our opinion that such discussions should be based entirely on a matter of economics. If it is merely necessary to run circuits through a wall to find a non-hazardous location, it is probable that the installation of non-explosion-proof equipment outside of the hazardous area will be more economical and frequently just as safe. Of course, the safety depends entirely upon the quality of the seals which isolate the non-explosion-proof equipment from the hazardous area. Here one has to depend entirely on the workmanship of the journeymen who install these seals.

In extensive installations where the equipment must be moved a considerable distance from the hazardous area in order to find a safe location, one frequently finds that the cost of conduit and wire to carry the circuits for the distance involved more than offsets the difference in cost between explosion-proof equipment and non-explosion-proof equipment.

As a typical case: In a check with several qualified industrial contractors we found that, on the average, these contractors estimate the cost of 1-inch conduit, equipped with three No. 8 conductors, at from $.81 to $1.19 per foot, depending upon such factors as the type of construction and labor costs. At an average estimated cost of $1 per foot, every 100 feet would cost $100. Disregarding the cost of such items as extra fittings and sealing Condulets, we might well consider this conduit run as serving a Size 2 motor starter. In most installations, separation of the motor and its starter will require additional conduit runs. A Size 2 explosion-proof motor starter costs approximately $140. A Size 2 NEMA Type-I non-explosion-proof motor starter costs $46. Thus it can be seen that this difference in cost is offset by a run of only 94 feet of 1-inch conduit with three No. 8 conductors.

If the installation is out-of-doors and a NEMA Type-IV starter is used in the non-hazardous area, the saving is only $58, which is equal to 58 feet of 1-inch conduit. The comparison becomes more favorable for explosion-proof equipment in those instances where it is necessary to run both load and power circuits to a remotely located starter.

In this comparison we have purposely overlooked the additional costs of longer control circuit runs, the need for a disconnect switch within sight of the motor, or the common practice of building special enclosures for non-explosion-proof equipment located outside of the hazardous area.

In general, we do not believe that the separation of the starter and motor by more than 35 feet is economically practical except when ideal circuit-layout conditions prevail.

All of this consideration applies only to the installation. It is obvious that, in many instances, efficiency of operation results when control equipment is located adjacent to the motors which are being controlled, and when such things as combination starters with built-in disconnect switches or circuit breakers provide further economies in installation and operation.

The same type of comparison may be made between an explosion-proof and a non-explosion-proof lighting panel.

The difference in cost is not simply the cost of the material. The real consideration is the final installed cost, including all of the circuit runs which may be necessary if the equipment is moved a distance away from the load which it controls. Particularly in the case of the explosion-proof lighting panel, it is frequently possible to locate the panel close to the lighting load and to use the panel for local control of these lights. This avoids the cost of installing explosion-proof switches in the lighted area. An explosion-proof lighting switch installed with the neces.ary sealing costs about two-thirds as much as a circuit in an explosion-proof panel. Here again it will be seen that, if a safe area is close to the hazardous area, economy will result from the installation of a non-explosion-proof panel. However, we may estimate that, if the safe area is 50 feet or more from the hazardous area, economy will usually result from the installation of the explosion-proof panel right in the lighted area and from its use for control of the lighting.

In all of these cases where the equipment is installed outside of the hazardous area, we cannot stress too strongly the need for careful supervision and frequent inspection of the seals which isolate the non-explosion-proof equipment from the hazardous area. From our personal inspection of plants around the country we have come to realize that approximately 50 percent of the installed sealing fittings are either empty or improperly filled. Several accidents have resulted directly from flammable vapors which leaked through seals which had been improperly made. Fatalities usually result when an explosion occurs in manually-operated non-explosion-proof panel boards, and in motor-control or circuit-breaker units.

## Conclusion

Economy is a poor substitute for safety. The operating crew of any plant is dependent upon the engineering force to provide it with equipment which not only will work, but which will work properly, and which will protect the lives of the crew as well as the property of the owner. Unless conditions are such that explosion-proof equipment simply cannot be obtained, we highly recommend that the entire job be performed with a completely explosion-proof installation. The equipment selected should be such that it will work satisfactorily under all conditions, whether the installation is indoors or out-of-doors, whether in a corrosive or non-corrosive atmosphere, and whether maintenance is expected to be first-quality or not.


REFERENCES

[1] The National Electrical Code, Natl. Board Fire Underwriters, New York, N. Y. (1951).

[2] Proposed Amendments to The National Electrical Code, 1951 edn, Natl. Fire Protection Assn., Boston, Mass.

[3] Standards for Construction of Explosion-proof Equipment, Underwriters' Laboratories, Inc., Chicago, Ill.

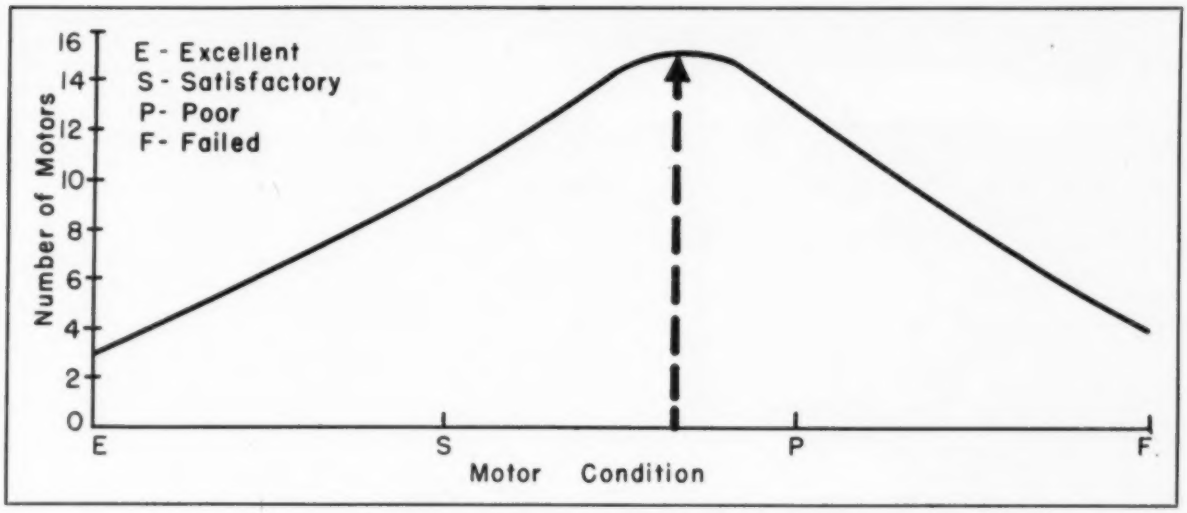



Figure 1. Condition of motors at end of 5-year test period.

# Are You Lubricating Motors Properly?

**Extensive tests reveal these maintenance secrets:**

- **Lubricate only once each three years**
- **Sealed bearing-housings are best**
- **High quality grease is a Must**
- **Motor speed is highly critical**

**Frank H. Walker, Jr.** and **William J. O'Meara**
The Atlantic Refining Company,
Philadelphia

THE POPULAR subject of motor maintenance has been explored, exposed, and expounded to a greater degree over the past decade by engineers and non-engineers in all walks of life than possibly any other single technical topic. Without exception, the motor manufacturer and people connected with maintenance by means of various forms of literature are ready and willing at all times to furnish information relative to how motors should be maintained.

Much of this information has been published many times and presented in numerous styles. The general experience of people in service and repair work, however, indicates the necessity for constant repetition in the selling of satisfactory maintenance procedures. The only other means proven more effective, but unfortunately more drastic, are the failures we can look back on. It is our feeling that this widely distributed type of information does a reasonably good job in acquainting all of us with the accepted methods and means for properly maintaining motors. It establishes a base from which we can work in making an evaluation of most economical maintenance procedures.

The shortcomings of such recommendations are recognized, however, in that they are based on conditions of tests which are apt to be considerably apart from those existing in petroleum refineries, where ambient conditions will vary depending on location of and within the refineries. This, coupled with the varying degree of conservatism among manufacturers, convinced us that we had better run our own tests and draw conclusions therefrom.

We have believed for a number of years that considerable advancement of motor lubrication practices could be made through maximum utilization of existing bearing construction and lubricants, without waiting for bearing-design changes and lubricant improvement. To this end various test programs were initiated, one of which will be discussed in detail in this paper.

The most attractive field in which a long-term test could be applied, from the standpoint of obtaining fairly conclusive data at minimum risk of such tests' being responsible for motor failures and consequent process outages, appeared to be with the smaller two-pole motors of 25 horsepower and less. Motors in this size range are more numerous in refinery operations than one might believe without taking a second look.

At Atlantic's Point Breeze refinery, in Philadelphia, this particular horsepower range represents 85 percent of the total number of 2454 motors presently in operation. This figure does not take into consideration the refinery expansion now in progress, which should more than double the total kilowatt demand, but no marked deviation from this percentage figure is anticipated.

**MAINTENANCE / OPERATION**

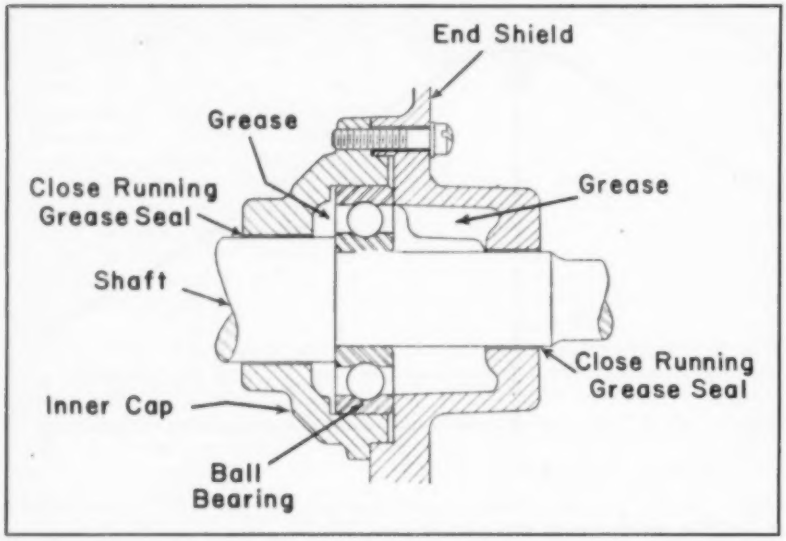



Figure 2. Cutaway of pulley end ball bearing housing for smaller tri-clad motors. (Sketch courtesy General Electric Company).

The recognized trend for most manufacturers toward grease-lubricated ball-bearing motors further suggested the possible value of collecting long-term operating data on this type of motor construction. Our generally accepted practice for relubrication of motors of these sizes operating in severe service (24 hours per day) was, at the time this program was started, once every six months—deviations from this schedule depending on other service conditions. Today the thinking on this is somewhat altered, as some motor manufacturers are offering so-called prelubricated bearing construction with no means for relubrication; and others, with conventional bearing design, are recommending relubrication at greatly increased intervals for all types of duty.

It is not the authors' intent critically to analyze or offer any specific recommendation regarding motor-bearing design, and by this we mean design of the entire bearing assembly with its lubrication facilities. We wish merely to emphasize, on the basis of our findings, the feasibility of designing for extended relubrication intervals, and to impress on the manufacturers how readily they can meet the need by the industry in general for motors which are designed for continuous operation with less and less attention required. This is made doubly important by the fact that rapid growth of the petroleum industry has necessitated gearing the refineries' mechanical forces to favor new installations and conversions, very probably at some sacrifice to the daily maintenance activities.

Also, such an extension of lubrication intervals makes feasible the elimination of the familiar grease cups and fittings, thereby insuring the motors against either improper lubrication or over-lubrication which, if permitted, can cause considerable harm.

This has been proved definitely over past years, back to when we first approached the problem of motor lubrication. At that time it was general practice to go all out to make it convenient for the operators and maintenance men to add more and more grease to the bearing reservoir. Whether it was by cup or gun, the result, as seen when the motor was opened, was always the same. Usually there would be more grease inside the stator enclosure than in the bearing housings. The bearings ran hotter because they slid rather than rolled; and, consequently, in spite of the abundance of lubricant, would seize and fail. For many years we have substituted plugs for grease fittings to eliminate over-greasing.

Today, with considerable progress brought about primarily through an advance of thinking rather than design, the picture is completely changed. This thinking, or revised conception of motor-bearing lubrication, is rapidly becoming standard accepted practice. Unfortunately, however, we are reaching the limit with what we have, and look to improved lubricants and design for further progress.

### Motor-Lubrication Test Conditions

In cooperation with General Electric Company, from whom the motors used in this test were purchased, a program referred to as the "five-year test" (approximately 40,000 hours of operation) was inaugurated early in 1947. The purpose of this test was simply to learn whether standard grease-lubricated ball-bearing "off-the-shelf" motors of the size and speed previously mentioned would operate continuously without relubrication over five years. Originally 34 motors were involved. However, a concurrent testing of three other motors of similar sizes over the same period makes it possible, for purposes herein, to look at the performance of 37 motors in all. These motors were installed on catalytic cracking units at the Philadelphia refinery (20) and the Atreco refinery at Port Arthur, Texas (17). All motors were of manufacturers' stand-

**TABLE A**

| MOTORS | | | GREASE | |
|---|---|---|---|---|
| Number | Horsepower | Speed | | |
| 9 | 7.5 | 3,600 | Oil content, per cent by weight | 80 |
| 2 | 10 | 3,600 | Acid No. | Nil* |
| 12 | 15 | 3,600 | Maximum free alkali (sodium hydroxide), percent | 0.3 |
| 13 | 20 | 3,600 | Drop point (minimum), fahrenheit | 290 |
| 1 | 25 | 3,600 | Saybolt Universal viscosity at 100 F., sec | 220 to 400 |
| | | | Worked consistency (ASTM D 217), mm | 27 to 29 |

* Acid No. is milligrams of potassium hydroxide (KOH) required to neutralize 1 g of grease. An acid number above 5 is considered harmfully corrosive to the bearing.

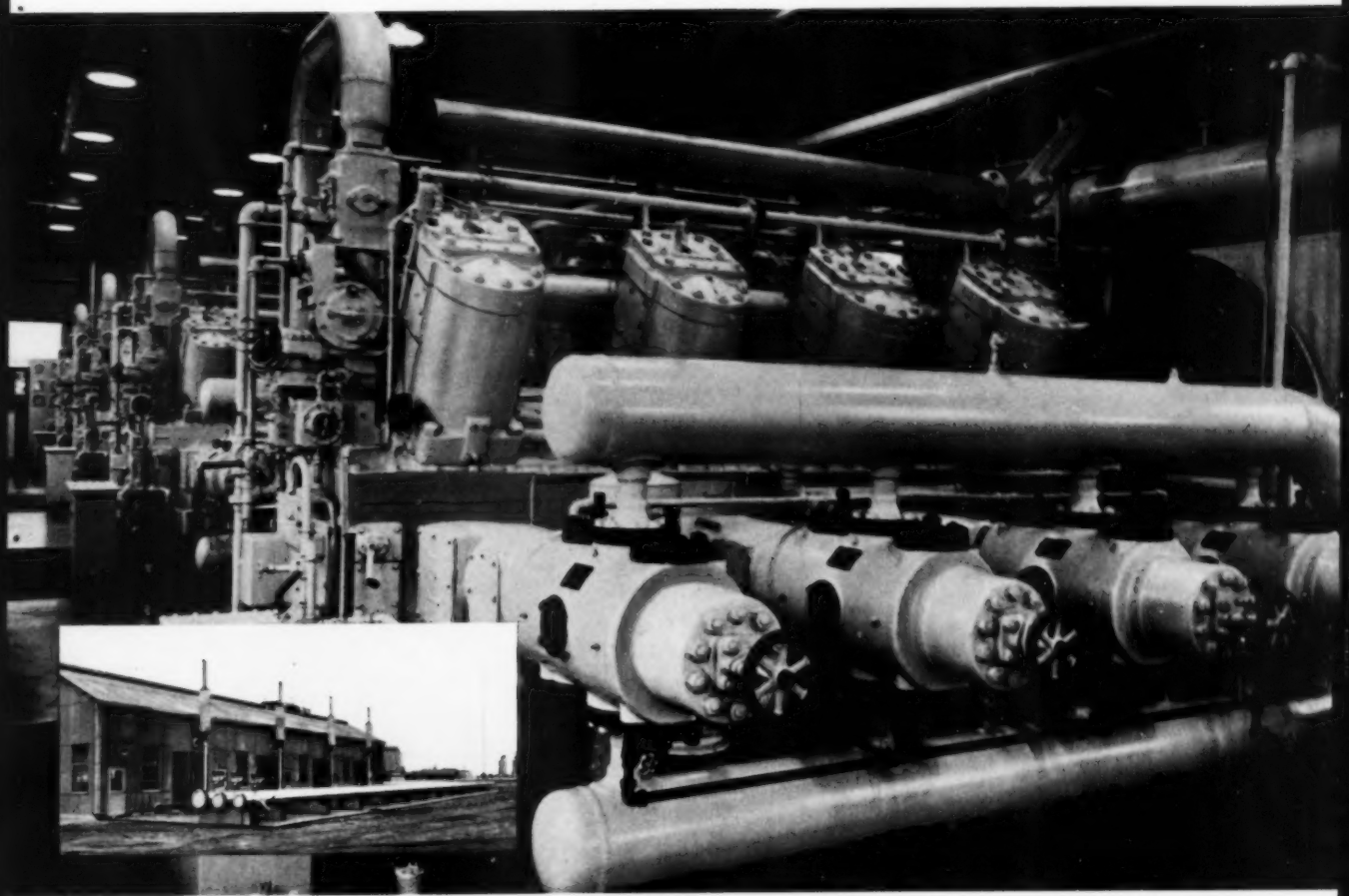
**TABLE B**

| | GREASE | BEARINGS |
|---|---|---|
| Excellent | Like new grease in all respects. (See grease specifications.) | Smooth-running; no corrosion or wearing of bearing parts; like new. |
| Satisfactory | Some discoloration; low acidity; little or no free oil; lubricating well; no odor. | Smooth-running; small amount of metal defects; not harmful to operation. |
| Poor | Bad discoloration; free oil; some caking or hardening; insufficient lubrication; rancid odor. | Rough-running; some apparent wear and corrosion. |
| Failed | No lubrication; completely hardened or slumped away from bearing; black color; low oil content, 60 to 70 percent; high acidity; granular. | Very rough; extreme wear with imminent failure. |

# BEAIRD-INGERSOLL-RAND

*Packaged Compressor Plant*

Lowest Cost Per Horsepower Installed



*These four packaged compressor plants are equipped with Ingersoll-Rand 440 horsepower 8SVG gas engine-driven compressors and Young radiators. They include all parts, connections and controls usually found in permanent compressor stations.*

## *Marketing Low-Pressure Field Gas—* HOW A NEW PIPE LINE PICKS UP PART OF ITS GAS LOAD

ONE OF UNITED GAS PIPE LINE COMPANY'S gathering systems required a field compressor station of almost 1700 horsepower to pick up low pressure gas from one of the sands in the Agua Dulce field in which pressures have declined, and bring it up to operating pressures of its transmission system. To provide this horsepower, United has installed a bank of four 440-H.P. Beaird-Ingersoll-Rand packaged compressor plants. They pick up this gas and compress it from approximately 450 p.s.i. to transmission line pressure of 700 p.s.i.

The four packaged compressors were designed, built and assembled in the Beaird plant. On location, the only installation required was grouting and bolting on a simple concrete slab and connecting up the suction and discharge lines.

*Let us give you all the facts about the economy of installing multiple Beaird-Ingersoll-Rand packaged compressor plants.*

**THE J. B. BEAIRD COMPANY, INC.**
SHREVEPORT, LOUISIANA

BEAIRD

PACKAGED COMPRESSOR PLANTS · CAST STEEL FITTINGS · PRESSURE BULK STORAGE · ANHYDROUS AMMONIA EQUIPMENT · L P GAS SYSTEMS

MACHINING · FABRICATING · STEEL WAREHOUSE

## BEAIRD *Cast Steel Fittings*

Fittings that fit

# *Why Beaird Fittings Fit*

You admire the sheer good looks of a piping installation as much as you appreciate its ability to withstand years of heavy use. And you know what a difference it makes in operation when the fittings are properly trued-up, all down the line. That's why Beaird has devoted a lot of attention, in the twenty-seven years it has made them, to producing fittings of exceptional trueness. That's why the companies who use them agree that *Beaird fittings fit.*

**FLANGES FULLY BACK-FACED** — provides smooth seat for stud bolt nuts — allows uniform stressing of bolts.

**BOLT HOLE CIRCLES AND FLANGE CIRCUMFERENCES CONCENTRIC WITH BORE** — assures true alignment of bore when flanges and bolt holes are lined up — speeds installation.

**GASKET FACES MACHINED WITH FINE PHONOGRAPHIC FINISH**–grips gaskets firmly—prevents leaks—reduces gasket replacement.

*Ask your supply house for the new catalog of Beaird cast steel fittings — or write to us direct.*

THE J. B. BEAIRD COMPANY, INC. SHREVEPORT, LOUISIANA

BEAIRD

MACHINING FABRICATING STEEL WAREHOUSE

PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

L P GAS SYSTEMS

**TABLE I**

**Test-Data Chart—Five-Year Motors, Point Breeze and Atreco Refineries, The Atlantic Refining Company**

| Date | Location | Motor No. | External Condition of Motor | Percent Full Load | Hours in Operation | BEARINGS | | GREASE | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Opposite Pulley End | Pulley End | Pulley End | Opposite Pulley End | |
| May, 1947 | ..... | .. | ..... | .. | ..... | Motors installed | ..... | ..... | ..... | ..... |
| January, 1948 | Point Breeze | 8 | OK | 99 | 5,330 | ..... | No inspection | ..... | ..... | Winding failure—grease changed. |
| September, 1948 | Point Breeze | 18 | OK | 35 | 10,700 | P | S | P | S | Defective coupling—bearings and grease changed. |
| September, 1948 | Atreco | 21 | OK | 61 | 10,550 | S | S | S | S | Removed for inspection—no change. |
| October, 1948 | Point Breeze | 18 | OK | 35 | 10,750* | S | P | S | S | OPE† bearing developed noise—damaged at coupling installation—bearings and grease changed. |
| June, 1949 | Point Breeze | 5 | Dirty | 77 | 16,650 | S | S | E-S | S | Removed for inspection—no change. |
| August, 1949 | Atreco | 21 | OK | 61 | 18,000 | S | S | S | S-P | Removed for inspection—no change. |
| August, 1950 | Atreco | 22 | OK | 62 | 26,000 | S | S | S-P | S-P | Removed for inspection—no change. |
| October, 1950 | Point Breeze | 15 | OK | 65 | 6,000 | S | S | E-S | E-S | Removed for inspection—no change. |
| January, 1951 | Atreco | 23 | OK | 50 | 29,300 | S | S | S | S | Winding failure—grease OK except contaminated by winding varnish—grease changed. |
| July, 1951 | Point Breeze | 6 | OK | 75 | 33,500 | S | S | S-P | P | Removed for inspection—grease changed. |
| August, 1951 | Atreco | 24 | Dirty | 77 | 24,780 | S | F | P | F | OPE bearing failure—OPE bearing and grease replaced; excessive dirt in frame reduced ventilation considerably—final inspection. |
| August, 1951 | Atreco | 25 | Dirty | 67 | 32,650 | S | P-F | S | F | Removed for OPE bearing noise—OPE bearing and grease replaced—poor ventilation. |
| November, 1951 | Point Breeze | 19 | OK | 87 | 36,600 | S | P-F | F | F | Bearings getting noisy—bearings and grease replaced. |
| March, 1952 | Atreco | 37 | Dirty | 61 | 38,600 | S | F | P | F | Removed for OPE bearing noise—final inspection. |
| June, 1952 | Point Breeze | 11 | OK | .. | 40,700 | S | S | S | S | Removed for final inspection. |
| July, 1952 | Atreco | 25 | OK | 67 | 41,900* | S | S | S | S | Removed for final inspection. |
| July, 1952 | Atreco | 29 | OK | 76 | 37,600 | S | S | P | P | Removed for final inspection. |
| July, 1952 | Atreco | 28 | OK | 48 | 37,000 | S | S | S-P | S-P | Removed for final inspection. |
| July, 1952 | Atreco | 30 | OK | 60 | 30,000 | S | S | S | P | Removed for final inspection. |
| August, 1952 | Atreco | 31 | OK | 60 | 42,000 | P | S-P | S-P | S | Removed for final inspection. |
| August, 1952 | Atreco | 32 | OK | 90 | 43,700 | S | P | P | P | Removed for final inspection. |
| August, 1952 | Atreco | 23 | Dirty | 50 | 41,700* | S | S | E | E | Removed for final inspection. |
| August, 1952 | Atreco | 22 | Dirty | 62 | 36,000 | S | S | P | P | Removed for final inspection. |
| September, 1952 | Atreco | 26 | OK | 62 | 23,500 | P | P | P | P | Removed for final inspection. |
| September, 1952 | Atreco | 27 | OK | 81 | 31,600 | S | S | P | P | Removed for final inspection. |
| December, 1952 | Atreco | 36 | Dirty | 60 | 30,000 | S | S | S | P | Removed for final inspection. |
| August, 1952 | Point Breeze | 6 | OK | 75 | 42,000* | P | S-P | P | P | Removed for final inspection. |
| August, 1952 | Point Breeze | 5 | OK | 77 | 42,000 | P | S-P | S-P | S-P | Removed for final inspection. |
| August, 1952 | Point Breeze | 8 | OK | 99 | 42,000* | S-P | S | S | S | Removed for final inspection. |
| August, 1952 | Point Breeze | 15 | OK | 65 | 20,800 | S | S | E | E | Removed for final inspection. |
| August, 1952 | Point Breeze | 17 | OK | .. | 42,000 | E | S | E-S | E-S | Removed for final inspection. |
| August, 1952 | Point Breeze | 3 | OK | 78 | 42,000 | P | P | P | P | Removed for final inspection. |
| August, 1952 | Point Breeze | 13 | OK | 43 | 42,000 | S | S | S | S | Removed for final inspection. |
| August, 1952 | Point Breeze | 2 | OK | 80 | 42,000 | P | S | P | S | Removed for final inspection. |
| August, 1952 | Point Breeze | 10 | OK | 92 | 42,000 | P | S-P | P | P | Removed for final inspection. |
| August, 1952 | Point Breeze | 4 | OK | 73 | 42,000 | S | E | S | E | Removed for final inspection. |
| August, 1952 | Point Breeze | 16 | OK | 87 | 42,000 | S | P | S | P | Removed for final inspection. |
| August, 1952 | Point Breeze | 14 | OK | 69 | 42,000 | P | S-P | S-P | S-P | Removed for final inspection. |
| August, 1952 | Point Breeze | 9 | OK | .. | 42,000 | S | S | S | S | Removed for final inspection. |
| August, 1952 | Point Breeze | 7 | OK | 72 | 42,000 | S | P | S | P | Removed for final inspection. |
| August, 1952 | Point Breeze | 12 | OK | .. | 38,700 | P | P | P | F | Removed for final inspection. |
| August, 1952 | Atreco | 33 | OK | 45 | 42,000 | S | S-P | S | P | Final inspection. |
| March, 1953 | Point Breeze | 18 | Dirty | 35 | 40,750 | S | S | E | S | Final inspection. |

* Grease changed at previous inspection. E—Excellent. S—Satisfactory. P—Poor. F—Failed. † OPE—opposite pulley end.
**Note:** Motors No. 34, 21, 35, 1, 19, and 20 have not as yet been removed for final inspection. Most of these motors are approaching 50,000 hours of operation.

ard explosion-proof construction with class "A" insulated windings, cast iron frames, and grease-lubricated standard ABEC-1 bearings. To insure the accuracy of the data obtained, the usual drilled and tapped hole into the bearing housing for field lubrication was omitted. In this way the possibility of someone's removing the plug and regreasing was eliminated. The bearings, which were of various makes, were greased at the factory, with the manufacturer's standard ball-bearing grease, oxidation-inhibited for long life. Each bearing housing was filled about three-quarters full of grease; i.e., visualizing a completely assembled motor, the space of the bearing housing which is not occupied by the shaft and bearing was approximately three-quarters full of grease (Figure 2).

As indicated, every effort was made to avoid special construction of any type in order that a truly representative test could be made. Motor and grease data are as shown in Table A.

The conditions of the test and periodic inspections were relatively simple so that as much useful information as possible could be obtained with inspections and bearing removals held to a minimum. These conditions were:

1) Motors operated continuously, except for process-unit turnarounds, over a five-year period.

2) Inspections were made on one motor at each refinery during each turnaround (approximately one-year intervals). These inspections were made at the manufacturer's local service shop in the presence of Atlantic's engineers and factory representatives.

3) Motors received absolutely no maintenance other than yearly cleaning of the frame, unless signs of pending failure appeared, i.e., noisy bearings. However, dirt which accumulated on the frame, in the fan enclosure, and in the ventilating slots between annual cleaning periods caused the motors to operate in varying degrees of cleanliness and, consequently, with different quality of ventilation. This provided means of determining the relative effect of resulting increase of operating temperature on lubricant and bearing life. Incidentally, it should be pointed out that, through a misunderstanding on this point, the motors at the Port Arthur refinery were not cleaned at all for the first three years of the test period. The end shield under the fan and some of the ventilating ducts on these motors were coated with 1/16 to 1/4 inch of adhesive oily dirt, thereby reducing heat transfer from the frame. In connection with this, it is significant to note that all four bearing failures or imminent failures from lubricant deterioration which occurred during the entire five-year period were on fan end bearings, and three of these were on Port Arthur motors.

4) The motors were inspected by removing each end shield, the apparent condition of the grease and bearing being noted without removal of bearings from the shaft. Samples of grease were removed for laboratory analysis. General checks were made to determine the condition of the winding, i.e., whether any oil had entered the stator frame. Inspection was also made to determine whether the bearings had turned in their cartridge, as well as for evidences of dirt and contamination. No new grease was added except where complete replacement was necessary, and care was taken to prevent dirt from being introduced to the original grease. If a bearing appeared rough and had to be removed from the shaft, the inner race was assumed to be disturbed, and it was then necessary to install a new bearing with new grease; and the test of that motor began or ended at this point, depending on length of service.

5) After completion of the five-year period, all bearings and samples of

grease from each bearing were sent to the manufacturer's laboratory for detailed analysis. The motors were rehabilitated with new bearings and returned to service.

### Test Data

Test data are assembled in Table 1 herein.

### Comments on Test

To simplify and condense the presentation of test data, the bearing and grease conditions observed during motor inspections are classified in the tabulation hereinafter.

The characteristic appearance and analysis at various stages of deterioration are grouped accordingly, but all characteristics in a group are not necessarily present at one time. See Table B.

Bearing inspections made at the manufacturer's service shops in order to be non-destructive were necessarily limited to visual and audible test. In this way the accuracy of classification is not precise; and, except for complete failures or readily noticeable defects, the bearing condition is described as satisfactory on the test chart. However, this is not true of the grease because samples were taken at each inspection, and laboratory analysis made.

When replacement of bearing, grease, or both was necessary for continued use of the motor, a breakdown of operating hours is noted from that time on to show actual operating hours for each bearing. When only the grease was replaced during motor inspection or repair (motors 8, 23, 6 in Table 1), the operating hours do not so indicate. However, a notation on total operating hours at final inspection points out this condition.

Motor load, as indicated on the test chart, was taken by spot check at completion of the test period, and possibly may not represent an average load over the five years. However, all motors are driving centrifugal pumps for a continuous process unit, with substantially constant throughput, and it is reasonable to assume fairly constant horsepower output.

In order to evaluate the motor-failure rate over the test period, the test motor failures are compared with similar motor failures at the Point Breeze refinery during 1952, on an annual percentage basis, as follows:

| | Test Motors (Figures in | Point Breeze Refinery Motors Percent) |
|---|---|---|
| Motor failures (windings) | 1.1 | 2.0 |
| Motor failures (bearings) | 2.2 | 2.5 |

By further definition, the winding failures include all complete rewinds regardless of cause, and exclude minor work such as terminal lead repair and winding revarnishing. The bearing failures include all bearing replacements where failure either occurred or was imminent. The comparatively low winding failure rate for the test motors is understandable, inasmuch as these motors are still relatively new as compared to all other refinery motors where the failure rate is approximately twice as great. This is somewhat offset by our experience that the higher winding casualty rate is with the smaller motors, such as we tested. Evaluation of the bearing-failure rate is more difficult, as the influencing factors are many and, because of the nature of the test, they have more pronounced effect on bearing life. We should like to point out that the bearing-failure rate for the test motors is less than what may be considered normal for the Point Breeze refinery. This could be construed as supporting evidence for a five-year lubrication plan on the basis that all bearings would be replaced at the end of this period. On the other hand, the average condition of the bearings and lubricant, as shown in Figure 1, indicates that further improvement should be made first, possibly to the point where the peak of the curve coincides with a *satisfactory* condition. Bearing replacements with a five-year plan would be high (20 percent), but savings would result primarily from less unscheduled outage time.

It is interesting to note at this point that a recent survey by Standard Oil Company (New Jersey), covering more than 13,000 motors at various locations in its system, indicated that approximately 2 percent of the motors require rewinding each year. We do not have any similar figures on bearing failures with which to make a comparison.

### Analysis of Test Data

In general, all bearings inspected after the test reflected the condition of the lubricant, particularly in the more advanced stages of deterioration. However, as may be seen by the data, all of the grease samples do not follow the same life pattern. This raises the question as to which of the many variables encountered plays a controlling part in determining the life of the bearing and grease. An attempt was made to correlate factors which tend to increase bearing tempertaure—such as motor load and bearing clearances—with conditions found after five years of operation. These data offered no evidence whatsoever that any of these factors noticeably influenced the test results. Had the range of motor sizes been greater, however, this may not have been the case.

As the motors and pumps were direct-coupled, the radial load on the bearings, aside from that caused by misalignment, is determined by the weight of the rotor, which is insignificant for the bearings used. The speed, on the other hand, is most important, as the effect of even the slightest degree of tightness or roughness in the bearing is multiplied at higher speeds. In this connection, we note that practically all published, successful tests of this type to date have been at 1800 rpm or less.

The motor-condition pattern, based on the classification of the worst bearing and grease in each motor as shown in Figure 1, closely resembles the familiar probability curve which, according to the bearing manufacturers, applies as well to bearing life.

Assuming that all the grease used for this test came out of the same batch, it seems reasonable to believe that, aside from manufacturing and installation defects, the ball bearing itself is the controlling variable, whereas the grease may be considered a fixed limitation insofar as bearing life is concerned. Referring again to Figure 1, it will be noticed that the peak of the curve representing the maximum number of motors for a given quality condition occurs closer to *poor*, thereby indicating that five years was too long a period for satisfactory results. Unfortunately, however, there are no means of determining the proper operating period except by arbitrary selection—which, in this case, would be somewhere between three and four years. This also points out the uselessness of removing a single motor at periodic intervals for bearing inspection. It is unlikely that the motor chosen would be representative.

The condition of the grease after test varied considerably between motors, but the characteristic physical changes leading to failure were generally common to all grease samples. These characteristics were previously listed under grease classification. It was observed that only a small portion of the grease in the reservoir contributed to lubrication of the bearing. This appeared to be caused by formation of oxidized surfaces of the grease, which would act as a barrier between a portion of the grease and the bearing. There also were layers of different colored grease in the bearing housings, further indicating that the grease was not mixing and, consequently, not being wholly effective as a lubricating medium.

In the raceways of the bearing, hardened soap was present which could not be removed by the common industrial solvents. This soap was only removable after the bearings had been cut open, thereby allowing better access to the surface; and even then it could be removed only by scraping the surface. In this connection, we feel that it is important to note that the usually prescribed method of relubricating by means of the grease gun should not be followed when operation is at extended lubricating intervals (5 or more years), as the condition of the lubricant may require more positive means of removal such as complete replacement of the bearing and lubricant.

The bearings for the most part were in good condition. Only one bearing was rusted in the raceway to the extent that continued operation would be doubtful. No actual pitting was observed in any of the bearing raceways. Approximately 30 percent of the bearings indicated varying degrees of creep or turn in the housing, thus causing fretting corrosion of the bearing's outside diameter. The presence of soap in the bearings interfered with accurate measurement of internal clearances; but, as found, radial clearance for the most part varied between 0.0001 and 0.0008 inch; and eccentricity was within the allowable 0.0006 inch except for one manufacturer, four of whose bearings were closer to 0.001 inch. The bearing cages were all found to be in generally satisfactory condition.

## Conclusions

Unfortunately the results of this test do not prove conclusively that it would be economically justifiable to operate motors of this size, bearing design, and speed, and in 24-hour service, without relubrication over a five-year period. However, it should be stated that our experience supports the generally recognized trend toward completely sealed bearing-housing construction and extended lubrication intervals. In fact, the Port Arthur refinery, as a result of its experience with this test, has initiated a permanent program with motors through 25-hp capacity, scheduled for three-year lubrication intervals. From an engineering standpoint, the three-year interval appears to be sufficiently on the conservative side, and is recommended for the present.

Greases, the most important factor in this type of operation, are being continually improved. Atlantic, for example, has recently developed, and has under test, a ball-bearing grease which promises to fulfill our wishes for five-year operation, and it is assumed that other grease manufacturers similarly are moving ahead in product quality. Bearings are being designed expressly for sealed operation over extended periods; and, although we have not had sufficient experience with this type of bearing to make comparisons, we have found that a much smaller quantity of grease than that used in these test motors is required for satisfactory lubrication over long periods. This is based on our observation that only the grease immediately adjacent to the bearing does the lubricating. The value of the remainder of the grease in the bearing housing is questionable.

The motor manufacturers, almost without exception, recognize the advantages of sealed lubrication, and they take various steps toward its use. Those who do not supply prelubricated ball bearings or sealed bearing housings suggest that a plug can be used in place of a grease fitting to obtain the same effect. The reason for this—or at least a reason to which we subscribe, based on this five-year test—is that the present-day commercial ball-bearing greases need further improvement to meet the rigors of five and more years of continuous motor operation in refinery service. However, this condition is being corrected, and we look forward with considerable optimism to future tests of the type herein described.

Although the search goes on for improved lubricants, it is essential that, at least for 3600-rpm operation, motor bearings be selected for smoother running quality by noise-level test, and sufficient radial clearance should be provided to minimize the possibility of tight operation at maximum motor temperature. As most leading motor manufacturers maintain close quality control over ball bearings used in their equipment, this selectivity should receive considerably more attention from the refinery maintenance people when replacements are made for 3600-rpm machines.

With improved greases and bearings made available to the motor manufacturer, it then becomes his responsibility to make the most effective use of these items through improved motor design.

Our experience with this test program strongly indicates that wherever long life without relubrication is desired, many of the present-day motor designs—and particularly relubrication practices—are in need of revision. This will very likely come about in the near future as further tests of this type are made with better lubricants.

In the preceding discussion, which has concerned only one phase of motor construction, we have tried to point out a more promising approach to motor maintenance through improved design. We feel that the best way to take care of an evil is to eliminate it; this applies equally to maintenance. With this thought in mind, we shall not be satisfied until we can obtain motors which can be installed and forgotten, except for exterior cleaning. This periodic cleaning, as highlighted by the test, is extremely important for proper operating temperature and resulting life of the lubricant, the oxidation rate of which increases approximately 50 percent for each 10-C rise of bearing temperature. This cleaning is essential also to winding life and motor-finish protection.

The reduction of motor maintenance, by way of improved bearing design, better lubricants, and insulating material, is made possible in no small way by use of totally enclosed frame construction. Except for a few signs of oil leakage into the stator frame, every motor involved in this test came through with windings which looked like new. This lends further support to Atlantic's policy of using totally enclosed motors exclusively in refinery service. As was mentioned previously, the outer appearance of several of these motors after operation over three years without cleaning was extremely bad. To attempt a life test of any sort under these conditions with other than totally enclosed motors would, in our estimation, be wasted effort. The trend with what used to be the open motors is toward enclosures which continually approach the totally enclosed. Nevertheless, any design short of this goal imposes a limitation on maintenance-free operation, which we feel is inconsistent with the improvements which have been made, and which are yet to be made, in bearings and their lubricants.

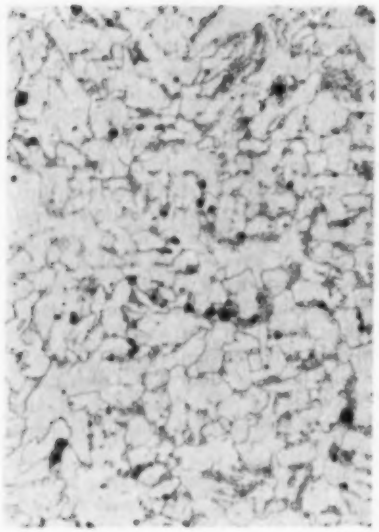
**CREDIT**

Original presentation as "Maintenance of Electric Motors" was before a session on electrical equipment at the mid-year meeting of the API's Division of Refining, New York, May 12, 1953.

**ACKNOWLEDGMENT**

The authors wish to acknowledge the contributions and cooperation of the General Electric Company during the five-year motor test.

1. Graphitization tests show: Large nodules like this.



2. . . . or scattered nodules, such as this specimen which failed the bend test.

3. . . . and this severe case found in a weld prober sample.

# How Serious Is Graphitization?

**Much research by API committee substantiates their answers to these questions:**

**►Is graphitization the real cause of vessel failures?**

**►Will the condition of graphitized equipment worsen with time?**

**►What can be done to prevent graphitization?**

**R. J. Fiorentino and A. M. Hall**
Battelle Memorial Institute
Columbus, Ohio

THE FIRST recorded instance of graphite formation in steel structures operating for long periods of time at elevated temperatures occurred in petroleum-refining equipment. The carbon-steel still tubes of a thermal-cracking unit were found to have graphitized after long service at elevated temperatures. The occurrence was reported by Kinzel and Moore in 1935.[1]

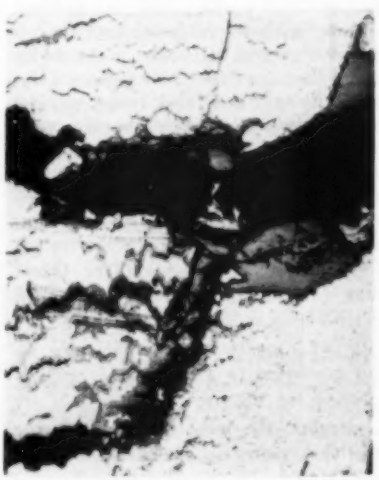
No further investigation of graphite formation in petroleum-refining equipment was made until 1943, when a welded joint in a carbon-molybdenum-steel steam line failed by graphitization at the Springdale Station of West Penn Power Company.[2] The occurrence stimulated limited examination of petroleum-refining equipment for evidence of graphitization. The results of the first of these examinations were generally negative. In a few cases, random graphitization was found, but it was apparently not detrimental to the equipment. As the examination of refining equipment continued, however, more cases of graphite formation were observed.

In addition to general or random graphitization, several instances were encountered in which the graphite had tended to concentrate near welded joints. Nodules of graphite had formed preferentially in that region of the parent metal that had been heated to the lower critical temperature of the steel during welding.

Failures in three graphitized catalytic-cracking units, constructed of integral-clad steel plate composed of ASTM Specification A201, Grade A, carbon-steel backing with AISI 347 stainless steel cladding, were reported in 1951.[3] The failures took the form of cracks up to eight feet long, and they appeared to have originated at or near the edge of weld-heat-affected

Original presentation was before the Mid-Year Meeting of the API Division of Refining, New York, May, 1953.

4. . . . while this one showed breaks at right angles to the bend axis.



5. . . . and this one demonstrated effects of stress and intergranular oxidation.

zones. The cracks occurred at the edge of longitudinal and girth welds as well as at the edge of fillet welds by which nozzle necks or manhole reinforcing pads were attached to the shell. Cracks were also observed to a greater or lesser degree in the stainless steel weld metal used with the cladding on the inside of the vessels. In only one of the three units were concentrations of graphite found in the carbon-steel backing of an extent which might have weakened the structure. In this unit, nodules of graphite were observed to be located in some of the cracks and may have influenced the paths of propagation of these cracks. However, it could not be said that graphitization had been a direct cause of the failures. In fact, the general appearance of the cracks was strongly suggestive of stress rupture accompanied by intergranular oxidation.

If only the comparatively harmless random type of graphitization had been found in the various petroleum-refinery units examined up to 1951, no great concern would be felt for the usefulness or safety of the equipment.

However, since some tendency has been found for graphite to concentrate near welded joints it was felt by the refining industry that a reexamination of the equipment was desirable. Segregated graphite is undesirable anywhere in a structure because of its direct weakening and embrittling effects, and because it constitutes a possible point of stress concentration. The possible hazard of this situation is increased when concentrated graphitization occurs at welded joints.

In view of this situation, and the fact that the problem is industry wide, the API Committee on Refinery Equipment authorized its Subcommittee on Unfired Pressure Vessels to set up a special subgroup to acquaint the industry with the general facts about graphitization. This group is known as the Subgroup on Deterioration of Steels at High Temperatures. In carrying out its mission, this subgroup has directed major attention toward unclad vessels; integrally clad vessels were considered a special problem, basically unrelated to graphitization.

A further objective of the subgroup has been to develop a program to determine how severe the graphitization problem is in the industry and what should be done about it. As a part of their program, the API subgroup initiated a project on graphitization in petroleum-refining equipment at Battelle Memorial Institute on May 1, 1952. The major objectives of this program are:

1) Determination of the present condition, with respect to damage done by graphitization, of that equipment in the industry which is operating under such conditions of temperature that graphitization might occur.
2) Estimation of (a) the future course of the graphitization observed in presently graphitized equipment, and (b) whether or not (and, if so, in what manner) presently ungraphitized equipment will graphitize in the future.
3) Establishment, if possible, of a factual basis for specifying plain carbon steels which will be satisfactorily resistant to graphite formation.

## Procedure

By distributing a series of reports on its activities, the API subgroup made its aims known to the industry and invited participation, especially by those with pressure vessels operating above 800 F. It was recommended that samples be taken of carbon- and carbon-molybdenum-steel vessels and pipe which had operated a sufficient length of time to warrant investigation for evidence of graphitization. Four years' operation (35,000 hours) was considered a reasonable minimum time limit for sampling unless the equipment had been operated in the range of 950 F. or above. In the latter case, the equipment might be sampled considerably earlier.

## Suggestions for Sampling

It was suggested that the samples from piping be taken at random where operating conditions indicated that graphitization might occur. Single samples transverse to welds, and including parent metal on both sides of the weld, were suggested. Occasionally, it might be advisable to obtain samples of piping remote from welds.

It was further recommended that at least three samples be taken from vessels as follows:

1) Transverse to the weld at the highest temperature zone.
2) Transverse to the weld where cyclic temperature variations occur.
3) A base-metal sample from a region which has been cold formed or otherwise plastically deformed.

The preferred sample was the so-called "boat sample" generated by a "weld prober." This type of sample was taken transverse to a weld and preferably included both heat-affected and unaffected parent metal on each side of the weld. Trepanned samples, if large enough, and if taken in the same way as "boat samples," were satisfactory also.

If the sample contained a weld and was of sufficient size, it was cut into three pieces transversely to the weld. The middle piece was machined to ⅛-inch thickness for a bend test. One outer piece was so cut that the weld, both heat-affected zones, and unaffected parent metal on both sides of the weld could be examined metallographically.

The bend-test specimen was macroetched with 10 percent nital to reveal the weld and weld-heat-affected zones. Two bends were then made in the specimen in such a way that the root of each bend was at the low-temperature edge of a weld-heat-affected zone.

The purpose of the metallographic examination and the bend test was to obtain information on Point 1 of the program, i.e., determination of the extent, if any, of damage done by graphitization.

The other outer piece was used for spectrographic and chemical analyses. At the beginning of the program, determinations were made for total residual aluminum (soluble plus insoluble aluminum), silicon, and, occasionally, carbon. Later on in the program, it appeared that nitrogen might be an important element influencing graphitization susceptibility. Accordingly, in the more recent examinations, the analytical work has been directed toward determining nitrogen, total aluminum, and silicon. The major purpose of the analytical work was to obtain information which might help establish whether or not a satisfactorily graphitization-resistant plain carbon steel is obtainable. This is Point 3 of the program.

The same piece that was used for the analytical work was reserved for an accelerated graphitization test. This treatment consisted of holding the specimen for 1000-hour periods at 1025 F., a temperature known from previous work on the graphitization of steam-piping steels[4] to promote graphite formation at a substantially higher rate than that obtained at temperatures of 800-950 F., the range of greatest interest from the standpoint of refinery operations.

The accelerated test was allowed to run 1000 hours, after which the samples were examined with the microscope for evidence of graphitization and then returned to the furnace for an additional period at 1025 F. This test was directed toward Point 2 of the program, that is, it was designed to aid in estimating the future course of graphite formation in presently graphitized equipment, and in estimating the graphitization susceptibility of the steel used in presently ungraphitized equipment.

If the sample did not contain a weld, the bend-test specimen was usually not prepared. However, metallographic examination, spectrographic and chemical analyses, and the accelerated graphitization test were performed in the manner already described. In addition, a McQuaid-Ehn test was made on several samples to determine whether information pertinent to the graphitization problem could thereby be obtained. It had been observed in investigations of graphitization in steam piping that the results of this test could be correlated with the susceptibility of the steel toward graphite formation.[5] Specifically, a tendency had been reported for steels which were "normal" in the McQuaid-Ehn test to be resistant and for steels "abnormal" in the test to be susceptible toward graphitization.

The test requires that the samples be case carburized to a sufficient depth to produce a region of hypereutectoid steel. At room temperature, this region consists of a network of cementite surrounding pearlitic areas. The cementite network traces the boundaries of the austenite grains that existed during carburization, while the pearlitic areas correspond to the austenite grains themselves.

In a steel considered normal, the structure within the grain boundaries is completely pearlitic and, if the grain is coarse, the cementite network consists of fine lines, well defined and continuous at the grain boundaries. In a steel considered abnormal, the pearlite within the grain boundaries is very coarse, irregularly lammellar, and is dissociated completely at the grain boundaries to form massive cementite and free ferrite. Also, the cementite network has a tendency to appear thicker and more discontinuous than in a normal steel.

The material for the McQuaid-Ehn test specimens was cut from available excess sample stock. The specimens, packed in a solid carburizing compound contained in a cast metal box, were placed into an electric furnace and held five hours at 1700 F. At the end of this period, the furnace was shut down and the specimens were allowed to cool to room temperature, after which they were prepared for metallographic examination.

## Results

At the time this report was written, 170 samples had been received from 12 participating companies. Of these samples, 159 had been examined with the microscope and analyzed spectrographically and chemically. In addition, an accelerated graphitization test of 1000 hours at 1025 F. had been completed on 65 samples.

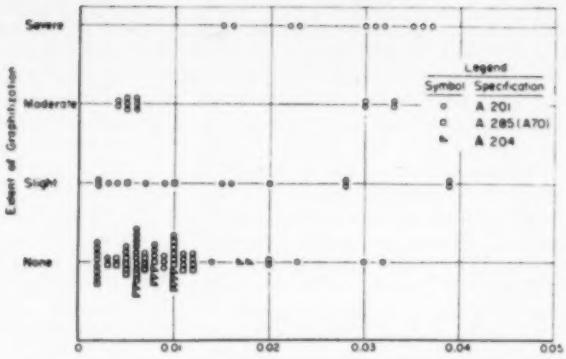



**Figure 6. Graphitization of plate samples heated at 890 F. or more for at least 35,000 hours.**

*Plate Samples*

The 159 samples examined included 131 representing plate and 28 representing pipe. In 86 of the plate-steel samples, no evidence of graphitization was observed. Of the other 45, which did graphitize, the extent of graphitization in 25 was considered to be slight and had no influence on the bend ductility of the samples. In these specimens, the graphite usually occurred in the parent metal remote from welds, though in two cases it preferred the low-temperature edge of the weld-heat-affected zone. In this group of samples, graphite formation varied from a few scattered nodules of small-to-moderate size to very occasional but fairly large nodules, as shown in Figure 1.

In 22 plate samples, a tendency was observed for the graphite to concentrate in the vicinity of the low-temperature edge of the weld-heat-affected zone. The extent of graphitization in two of these samples was considered "slight," in 13 it was considered "moderate" and in seven, "severe." The bend-test specimens cut from the "severely" graphitized samples and from one of the "moderately" graphitized samples broke at the weld-heat-affected zone, and metallographic examination indicated that graphite formation had been influential in causing the fracture. The extent of graphitization in one of the "severely" graphitized samples is illustrated in Figure 2, while that in another is shown at low magnification in Figure 3. The samples which had graphitized sufficiently to break in the bend test represented three reactors.

Frequently, fractures occurred at right angles to the bend axis along stringers of nonmetallic inclusions in the metal. These breaks were not influenced by graphite formation. Their appearance is illustrated in Figure 4.

One sample, cut from the junction of the reinforcement pad of a 56-inch-diameter manway and a shell, contained a crack. Metallographic examination revealed the presence of a few scattered graphite nodules in the parent metal. However, no graphite was observed in the immediate area surrounding the crack, and no evidence was found which would indicate that graphitization had contributed to the failure.

The crack is shown in transverse section in Figure 5. It is composed of a major crack and "tributary" cracks. The appearance of the family of cracks and the surrounding metal suggests that intergranular oxidation took place. The photomicrograph shows the presence of gray iron oxide scale along the edges of the cracks, and their appearance also indicate that a high stress concentration was operative. It is likely that the failure could be attributed to stress and oxidation acting together.

*Pipe Samples*

In 11 of the 28 pipe samples, no evidence of graphite was found. Among the other 17, which did graphitize, the extent of graphitization in four was considered "slight," in five it was considered "moderate," and in eight it was rated "severe." Unfortunately, in no instance where the extent of graphitization was considered "severe" was there sufficient sample to permit making a bend test.

*McQuaid-Ehn Tests*

This test was carried out on 19 samples. As expected, it was found that the results could be correlated quite well with total aluminum content. The test did not appear to give additional information applicable to the graphitization problem.

## Accelerated Graphitization Tests

The results of the accelerated graphitization tests made to date have permitted certain limited observations on the probable course of graphitization in the steels sampled.

In six samples where graphitization had already been observed as a result of service, the accelerated test suggested that further graphitization could definitely be expected. In these instances, the samples showed a tendency toward the formation of graphite concentrations in regions related to the welding cycle.

In ten samples where no graphite had been observed as removed from the refinery equipment, the results of the accelerated test showed that the steels represented were definitely susceptible to graphitization. However, there appeared to be differences in degree of graphitization susceptibility. In some cases, even though susceptibility was shown by a steel which had not graphitized in service, there seemed little probability that graphite would actually form in service because of the low metal temperatures involved.

Among the balance of the samples tested were many which had not graphitized in service and did not graphitize in the accelerated test. Also, there were numerous samples which had graphitized in service but showed no measurable increase in graphite formation in the accelerated test. In the case of those specimens which had showed no graphite at all, comparatively good resistance to graphitization could be assumed for the time being, especially where service temperature had been high and service time long. However, it would be advisable to reserve judgment in these cases pending the results obtained from a continuation of the test.

The results of the accelerated graphitization test are discussed from the viewpoint of steel composition and melting practice in the following section.

### Composition and Steel-Making Practice

In an effort to obtain data on steel composition and melting practice, which might form the basis for the specification of a steel satisfactorily resistant to graphitization, a considerable number of chemical and spectrographic determinations were made. At first, silicon, total residual aluminum, and, occasionally, carbon were determined. Later, when the progress of other research on graphitization indicated that nitrogen tended to inhibit graphitization, the analytical work was directed toward determination of total aluminum, silicon, and nitrogen. The amount of sample available necessarily limited the number of analyses that could be made per sample.

Accumulated analytical data were examined from many viewpoints in an effort to determine whether consistent relationships existed that had a bearing on the extent of graphitization observed. Service time, average service temperature, and the type of steel (whether plate or pipe as well as whether carbon, carbon-silicon, or carbon-molybdenum) were also taken into account.

It should be pointed out that the values reported for average service temperature were obtained by the contributing companies under field conditions, and in some cases uncertainty necessarily exists as to their significance. In addition, the temperature values usually reported appeared to be "stream temperatures" rather than "metal temperatures," and a reliable estimate of metal temperature could not be secured.

The extent of graphite formation found in all the samples which had experienced an average service temperature of 890 F. or more for at least 35,000 hours was examined as a function of aluminum content as well as of silicon content. These conditions of time and temperature were chosen as arbitrary minima. Among the plate steels, it was observed that in every case where graphitization was rated "severe" the steel had a high total aluminum content, i.e., 0.015 percent or more. In addition, 50 percent of the plate steels containing 0.015 percent or more total aluminum had graphitized moderately or severely, whereas only 25 percent had shown no graphite. In contrast to this, none of the plate steels containing less than 0.015 percent total aluminum had graphitized "severely," only 9 percent "moderately," while 80 percent showed no graphite. Figure 6 illustrates these relationships. Among the pipe steels, the data were too scant to permit establishment of trends. In the one case of "severe" graphitization in a pipe steel where an analytical determination was available, the total aluminum content was reported to be less than 0.005 percent.

The influence of service temperature was then studied in relation to the aluminum and silicon contents of the steels. Samples of steel in service at any temperature for at least 35,000 hours were used. While no close correlation with either aluminum or silicon content seemed evident, it was observed that, except in one case (carbon steel, ASTM Specification A-285, containing 0.042% Al and 0.21% Si), only slight graphitization, if any, occurred at average service temperatures below 890 F.

In addition, the influence of service time in conjunction with average service temperature was examined simultaneously with aluminum and silicon contents. No correlation with composition was observed. It could be said, however, that temperature played a more important role in inducing graphitization than did time.

In 40 cases, nitrogen analyses were available. However, with four exceptions, the nitrogen contents of the steels fell within the range of 0.003 to 0.006 percent. This range was too narrow to permit correlation with graphitization behavior.

The statistics relating the type of steel to graphitization extent are as shown in Table A.

**TABLE A**

| PLATE STEELS | NUMBER OF SAMPLES | | |
|---|---|---|---|
| ASTM Specification | A285 (A70) | A201 | A204 |
| Extent of Graphitization: | | | |
| None | 26 | 36 | 15 |
| Slight | 6 | 19 | ... |
| Moderate | 2 | 11 | ... |
| Severe | ... | 7 | ... |
| PIPE STEELS | | | |
| ASTM Specification | A161 | A106 | A206 |
| Extent of Graphitization: | | | |
| None | ... | 6 | 5 |
| Slight | 1 | 3 | ... |
| Moderate | ... | 5 | ... |
| Severe | ... | 8 | ... |

One sample was not considered because it was all weld metal, while eight others were not included because the specifications for them were not known.

The tabulation appears to suggest that carbon-steel plate (A285 and A70) is more resistant to graphite formation than is carbon-silicon plate (A201), while carbon pipe steel is quite susceptible to graphitization. However, when average service temperature was taken into account, it was found that this supposition could not be made. It was noted that the majority of the carbon plate steels were used at temperatures below 900 F., while most of the carbon-silicon plate steels were used in the range 900-1000 F. and several were used at temperatures well above 1000 F. On the other hand, many of the carbon pipe steels were used at temperatures above 1000 F.

It could therefore be said that, on the average, service temperature was more severe for the carbon-silicon plate than the carbon plate steels. Thus, the tabulation actually reflects severity of service conditions rather than performance of type of steel, in the case of the carbon and carbon-silicon steels.

The tabulation also shows that in no case did either the carbon-molybdenum plate steels (A204) or the carbon-molybdenum pipe steels

(A206) show any evidence of graphitization. These steels were divided quite uniformly with regard to service temperature, about 1/3 being used below 900 F., about 1/3 in the range 900-1000 F. and about 1/3 at temperatures above 1000 F. The results tend to confirm the experience of the power industry to the effect that carbon-molybdenum steam-pipe steels were found to be somewhat more resistant to graphitization than plain-carbon steels. However, the power industry found numerous cases of graphite formation in carbon-molybdenum steels and, in particular, found instances in these steels of an extreme concentration of graphite which came to be termed "eyebrow" type graphite formation. In fact, that industry now favors chromium-molybdenum steels, containing more than 0.5 percent chromium i.e., A315, for steam piping to be used at service temperatures of about 950 F. and above. Caution must therefore be used in assessing the results presented here on the carbon-molybdenum steels.

### Accelerated Graphitization Tests

The group of samples given the accelerated graphitization test of 1000 hours at 1025 F. was also studied for effects due to composition and type of steel.

It was considered significant that none of the 10 carbon-molybdenum steel samples tested showed any evidence of graphite formation after test. This group was composed of 8 plate steels (A204) and two pipe steels (A206). The aluminum content of these steels ranged from 0.002 to 0.065 percent, while silicon varied from 0.10 to 0.32 percent. No nitrogen analyses were available for any of these particular steels.

Among the other specimens given the accelerated test, the results were as shown in Table B.

**TABLE B**

| | NUMBER OF SPECIMENS | | |
|---|---|---|---|
| ASTM Specification | A285 (A70) | A201 | A106 |
| Extent of Graphitization: | | | |
| None | 18 | 9 | 1 |
| Slight | 3 | 14 | |
| Moderate | 1 | 5 | 1 |
| Severe | .. | 3 | .. |
| Graphitization Unchanged by Test | 17 | 21 | 2 |
| Graphitization Increased by Test | 5 | 10 | 0 |

The three severely graphitized specimens contained 0.030, 0.030, and 0.073 percent Al, respectively, with corresponding silicon contents of 0.16, 0.18, and 0.20 percent. The aluminum content of the moderately graphitized specimens ranged from 0.002 to 0.030 percent with silicon varying from 0.01 to 0.22 percent.

### Discussion

In the several instances where "severe" graphitization was found, examination suggested that mechanical properties may have been impaired. The extent of such impairment is a matter for further investigation. Should further study demonstrate that graphitization had caused significant deterioration of mechanical properties, then remedial measures become important.

While no instances of failure due to graphitization have occurred, some vessels have been built with internal insulation to reduce metal temperatures. Other vessels have been constructed from graphitization-resistant alloy steels. Still others are being built of carbon steels.

Insofar as new equipment is concerned, the question of the kind of steel to use becomes of major importance, should graphitization be considered a definite cause or even a probable cause of failure. The results of the investigation, thus far, have shown that neither carbon steels, such as made to ASTM Specification A285, nor carbon-silicon steels represented by ASTM Specification A201, are immune to graphitization. Moreover, both types are apt to develop undesirable concentrations of graphite in weld-heat-affected metal. No simple relationship seems to exist between graphitization susceptibility and such variables of composition as total aluminum, silicon, and nitrogen.

The strongest lead, in the matter of composition, is the immunity toward graphitization thus far shown by the carbon-molybdenum steels. This finding, however, must be viewed with caution because carbon-molybdenum steels are known to graphitize.[6] The results indicate that carbon-molybdenum steels are markedly more resistant to graphitization in refinery equipment than are the carbon and carbon-silicon steels tested. They may prove to be satisfactorily resistant for the purposes of the industry. This remains to be demonstrated by the results of continued investigation.

### Conclusions

1) To date, no instances of failure in refinery equipment have been observed in which graphitization could be considered either as the direct cause or as an important contributing factor.

2) In 8 out of 131 plate-steel samples (6.1 percent), the extent and form of graphitization was such as to cause the specimens to crack in a cold-bend test.

3) Though several pipe-steel samples were considered to have graphitized "severely," the material available was insufficient to permit determination of their cold-bend properties.

4) In no case was the continuous "eyebrow" type of graphite formation, such as has been encountered by the power industry, observed even in "severely" graphitized samples.

5) One plate sample contained a fracture which was considered to have been caused by a combination of stress concentration and high-temperature oxidation. No evidence was found that graphitization had contributed to the failure.

6) Accelerated graphitization tests completed thus far have shown some cases in which further graphitization is to be expected in service. In other cases, the steels were susceptible to graphitization though not graphitized in service. In many cases, average service temperature was low enough that graphitization would not be expected, even in a susceptible steel.

7) Among the plate-steel samples, it was observed that total aluminum content tended to influence graphitization susceptibility. Some 50 percent of the plate steels containing 0.015 percent or more total aluminum had graphitized "moderately" or "severely," while only 25 percent showed no graphitization. In contrast, no plate steels containing less than 0.015 percent total aluminum had graphitized "severely," only 9 percent "moderately," while 80 percent showed no graphitization.

Regarding pipe steels, the data were too meager to permit establishment of trends.

8) None of the carbon-molybdenum steels thus far examined, whether plate or pipe, showed any evidence of graphitization. These results indicate that the carbon-molybdenum steels are markedly more resistant to graphitization in refinery equipment than are carbon or carbon-silicon steels.

#### REFERENCES


[1] A. B. Kinzel and R. W. Moore, "Graphite in Low Carbon Steel," *Trans. AIME*, Vol. 116, 1935, pp. 318.

[2] Progress Report No. 1 on "Survey of Graphitization of Piping," Edison Electric Institute Bulletin 11, 1943, pp. 307-308, 318.

[3] D. B. Rossheim, J. J. Murphy, R. H. Caughey, W. B. Hoyt, "Recent Experience in Examination of High-Temperature Catalytic Cracking Pressure Equipment," ASME Paper No. 51-A-26, November, 1951, pp. 59.

[4] S.L. Hoyt, R. D. Williams, and A. M. Hall, "Summary Report on the Joint EEI-AEIC Investigation of Graphitization of Piping," *Trans. AIME*, Vol. 68, 1946, pp. 571-580.

[5] H. J. Kerr and F. Eberle, "Graphitization of Low-Carbon and Low-Carbon-Molybdenum Steels," ASTM-ASME Symposium on Graphitization, 1944.

[6] R. W. Emerson, "Carbide Instability of Carbon-Molybdenum Steel Piping," ASTM-ASME Symposium on Graphitization, 1943.

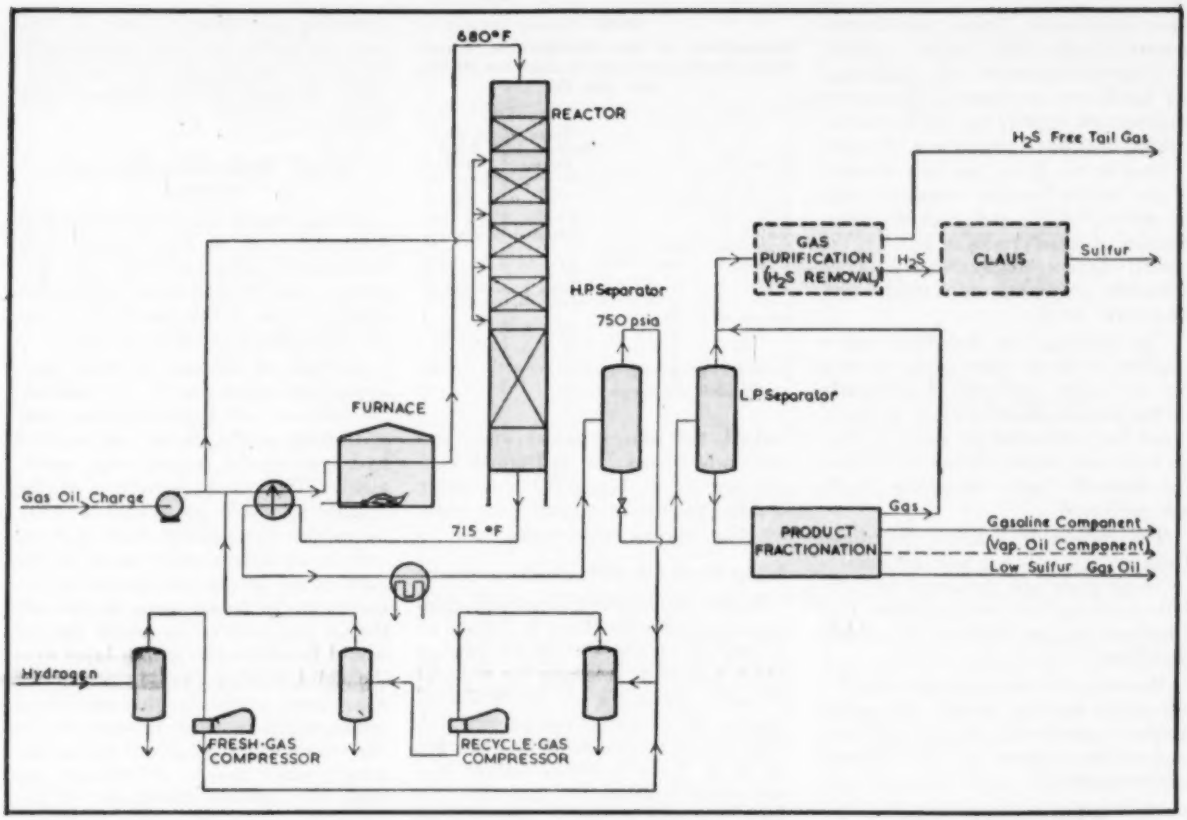



Figure 1. Flow diagram of commercial trickle hydrodesulfurization plant.

# New Shell Hydrodesulfurization Process Shows These Features

- Application of "trickle" technique
- 85 to 90 percent sulfur removal
- High-octane gasoline as a by-product

**H. Hoog, H. G. Klinkert and A. Schaafsma**

THIS IMPROVED catalytic hydrodesulfurization process upgrades high-sulfur stocks, such as straight-run and catalytically cracked gas oils, and shale oils. The application of the "trickle" technique, in which the feed flows downwardly as a thin liquid film over catalyst particles in a fixed bed in the presence of a low hydrogen-recycle flow, results in a reduction of 15 to 20 percent in capital investment and operating cost relative to vapor-phase operation. High-boiling feed stocks may be more economically desulfurized by the process, inasmuch as it is not necessary to vaporize completely the reactor-charge stream. A sulfur removal of 85 to 90 percent is easily obtained, with long catalyst life without regeneration.

Mr. Hoog is with Koninklijke-Shell (Royal Dutch Shell) Laboratorium, Amsterdam, THE NETHERLANDS. Messrs. Klinkert and Schaafsma are with Bataafsche Petroleum Maatschappij, The Hague, THE NETHERLANDS.

## Answer to Sulfur Problem

For the past decade the sulfur content of crude oil and its derivatives has been causing more and more concern to refiners.

Thus, in the United States, the proportion of sour to sweet crudes has increased,[1, 2a] inasmuch as the relative shortage of petroleum has stimulated the refining of high-sulfur crudes the production of which normally would have been held back. Among others,

some California, Texas, and Southeastern crudes show sulfur contents of 3 percent or above. Also shale and tar sands are receiving increased attention, and usually the oil therefrom is high in sulfur, oxygen, and nitrogen.

Outside the U. S., the vast reserves of the Middle East are invariably high in sulfur;[3(a),3(b)] and, with the introduction of these crudes in Europe, the sulfur content of various products definitely compares unfavorably with its prewar level.

The situation as described rather conflicts with the customer's demand for low-sulfur products. Particularly in the field of diesel fuels it is recognized that sulfur has an adverse effect on wear and engine cleanliness.[4] Also, for domestic fuels, low-sulfur stocks are preferred.

The increasing demand for diesel fuels and gas oils has induced refiners to blend cycle oils produced by catalytic cracking into virgin stocks, thus increasing the volume of middle distillates.

However, in the catalytic cracking of sulfur-bearing stock, the sulfur tends to concentrate in the cycle oil, and sulfur contents up to 3 percent are encountered.

### What Surveys Show

The position is clearly reflected in the national annual diesel-fuel surveys conducted by the American Petroleum Institute in cooperation with the U. S. Bureau of Mines.[5] Although the average quality of the fuels is still quite satisfactory, several samples show large deviations in sulfur content, gravity, and diesel index; and it is obvious that these samples contain an appreciable percentage of catalytically cracked cycle oil from medium or high-sulfur stocks.

The demand for high-quality middle distillates calls for refinery methods to solve the sulfur problem.

Solvent extraction has already been proposed as a means for quality improvement of virgin gas and oil catalytically cracked cycle oil. Commercial-scale furfural extraction[6] is being applied for the reduction of sulfur in gas oils. Also hydrogen fluoride[7] is a suitable agent to reduce the sulfur content.

However, solvent extraction has a few shortcomings, viz.:

*a)* The aromatic extracts are high in sulfur and, by the nature of the process, are degraded in value.

*b)* The low specific gravity of the raffinate has an adverse effect on the calorific value or mileage per gallon.

Hydrodesulfurization, on the other hand, has none of these disadvantages.

**TABLE 1**

**Comparison of Two Catalysts in Trickle Hydrodesulfurization of Straight-run Middle East Gas Oil**

| CATALYST: | Cobalt-Molybdenum-Alumina | | Tungsten-Nickel Sulfide | |
|---|---|---|---|---|
| Temperature, fahrenheit | 708 | | 663 | |
| Pressure, psia | 750 | | 750 | |
| Reactor height | 6 ft. 3 in. | | 6 ft. 3 in. | |
| Gas flow | Concurrent | | Concurrent | |
| Liquid hourly space velocity, volumes per volume per hour | 2.4 | 3.6 | 2.4 | 3.5 |
| | Sulfur Removal, Percent | | | |
| Gas rate, scf per bbl:* | | | | |
| 1250 | 89 | 84 | | 82 |
| 625 | 87 | .. | 90 | 78 |

* Standard cubic feet per barrel.

Indeed, the process shows some features which make it well worth considering as a means for upgrading middle distillates, in particular catalytically cracked cycle stocks.

### What Hydrodesulfurization Means

In this discussion hydrodesulfurization of middle distillates is defined as a catalytic hydrogenation process which has as its sole aim the removal of sulfur from the oil by means of reaction of the sulfur compounds with a minimum consumption of hydrogen so as to form hydrogen sulfide and one or two hydrocarbon molecules. As such, it should be clearly distinguished from hydrogenation operations which, although they also result in sulfur removal, are carried out primarily with other intentions, e.g., hydrogenation of catalytically cracked cycle stocks in order to improve the cetane number, or in order to make them more suitable as catalytic cracking stock.[8,9]

Hydrodesulfurization processes within the scope of this definition are usually carried out at moderate pressures (300 to 750 psi) and at moderate temperatures (650 to 750 F.), with a variety of catalysts. In spite of the fact that such processes have been known for a number of years,[9,10,11,12,13] commercial-scale application has been limited primarily because of the high production cost of hydrogen. However, with the development of catalytic reforming as a refinery tool, a source of cheap hydrogen has become available. This, together with improvements in the hydrodesulfurization technique, has brought its operating cost down to such a level that application becomes economically attractive, particularly for desulfurization of catalytically cracked cycle stocks.

**CREDIT**

**Original presentation as "Shell Hydrodesulfurization Process" was at the 18th Mid-Year Meeting of the American Petroleum Institute's Division of Refining, New York, May 13, 1953.**

### "Shell" Hydrodesulfurization Process

During recent years the Amsterdam Laboratories of the Royal Dutch Shell Group have carried out extensive laboratory and pilot-plant investigations aiming at the development of a low-cost hydrodesulfurization process.

A study of the various items governing the total cost by hydrodesulfurization of oil distillates shows that a decrease in the amount of recycled hydrogen would reduce costs appreciably. However, reduction of the amount of cycle gas considerably below the conventional level will result in conditions where most of the feed is no longer vaporized but remains in the liquid state. It was felt that a procedure in which the oil would be trickled in a thin layer over the solid catalyst, and in which the gas phase would be the continuous phase, might be more appropriate for the treatment of liquid oil with a relatively small amount of hydrogen gas than the upflow operation. It was found that, under these low hydrogen-recycle conditions, the catalyst activity was not impaired at all. Moreover, it could be shown that this technique could be applied to a variety of base materials and with different catalysts.

### Significant Savings

The use of such low-hydrogen recycle rates as made possible by this technique involves a significant saving in operating and capital cost—not only because of the reduced capacity and power consumption of the recycle-hydrogen compressors, but also because of a reduction in the heat-transfer surface area required; for a considerably smaller amount of heat has to be transferred, both through feed-products heat exchange and in a fired preheater.

The study of the various cost items further indicated that the catalyst should be selective under the operating conditions applied; i.e., hydrogen consumption should be limited essentially to that required for the desulfurization reaction; while side reactions, such as hydrogenation of aromatics, should be suppressed. Although catalysts of widely varying composition were found to possess this feature (e.g., a combination of molybdenum oxide, magnesium oxide, and zinc oxide, as well as a combina-

tion of cobalt oxide, molybdenum oxide, and aluminum oxide), a catalyst prepared by impregnation of a bauxite carrier with a cobalt-nitrate and ammonium molybdate solution (containing cobalt and molybdenum in an atomic ratio of 1 to 5) was found to give optimum hydrodesulfurization performance.[16] This catalyst gave, at the same time, very little hydrogenation of aromatics, even at a high degree of sulfur removal.[17]

A cheap and mechanically rugged form for the carrier was developed by extruding a paste of bauxite and by introducing a special technique aimed at the production of final granules without sharp edges.[1]

The standard catalyst used had the following composition: 0.8 parts cobalt, 6.5 parts molybdenum, 100 parts bauxite carrier. The life of such a catalyst was excellent under the operating conditions applied.

No complete review of the development work on the process can be given herein, but a few illustrative results will be discussed taken from the pilot-plant work carried out in a 3-inch reactor which contained 3 catalyst beds, each 6 feet in height—with a throughput of 5 to 10 barrels per day.

### Effect of Hydrogen-Recycle Rate

The experimental results given in Figure 2 demonstrate that, under otherwise equal conditions, desulfurization is most complete at hydrogen-recycle rates corresponding to the break point between trickle and vapor-phase operation.

The decrease in desulfurization with a further increase in hydrogen-recycle rate for vapor-phase operation may be explained by the fact that contact time and oil partial pressure are decreased. At hydrogen-recycle rates below the break point the desulfurization decreases, presumably because of the lower mass-transfer rate caused by the resistance of the liquid film on the catalyst surface. The decrease in desulfurization at very low hydrogen-recycle rates may be attributed to the lower hydrogen partial pressure and the higher hydrogen-sulfide partial pressure existing in the lower part of the reactor.

Figure 2 shows clearly that the reduction in sulfur removal which was effected when operation was at low hydrogen-recycle rates in trickle operation (250 to 1500 scf per barrel), as compared with vapor-phase operation at hydrogen-recycle rates in the order of 5000 to 10,000 scf per barrel, is relatively small. This has been confirmed by pilot-plant experiments with a number of stocks, including catalytically cracked cycle stocks.

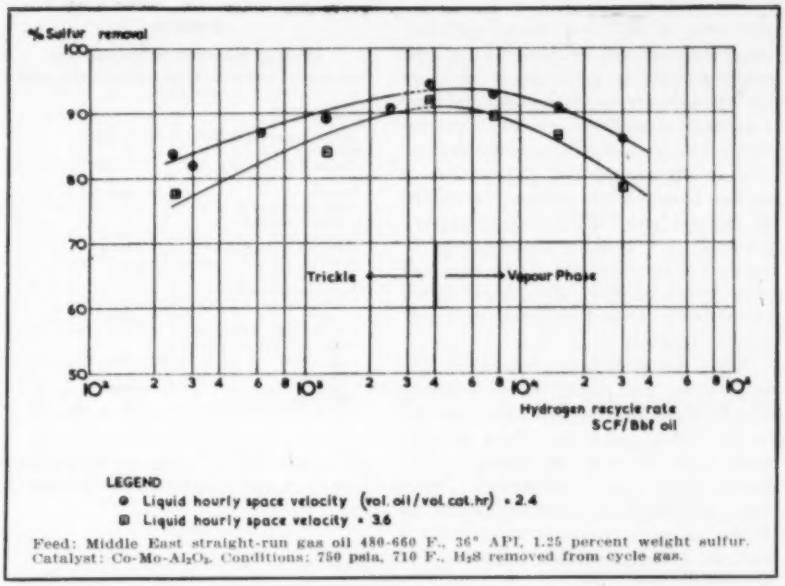



**Figure 2. Hydrodesulfurization: Effect of Hydrogen Recycle Rate on Sulfur Removal.**

Economic evaluations on the basis of these results have shown that, when a comparison is made for a given sulfur content of the product, the cost of the small increase in reactor volume required is far out-weighed by the reduction in cost of gas-recycle compressors and heat-transfer equipment. The over-all capital investment required for the hydrogenation unit proper is in the order of 15 to 20 percent lower for trickle operations; and a similar reduction in operating cost is obtained.

### Effect of Hydrogen Sulfide in the Recycle Gas

In the early work hydrogen sulfide was always removed from the recycle gas. However, as it became clear that the trickle operation could successfully be carried out at very low gas-cycle rates—in which case substantial hydrogen-sulfide concentrations are built up in the lower part of the reactor without impairment of the catalyst activity—comparative pilot-plant experiments were carried out in which hydrogen sulfide was not removed from the recycle gas. Typical results, given in Table 2, show that the reduction in sulfur removal, which resulted from leaving the hydrogen sulfide in the recycle gas, is very small; further, no permanent loss of catalyst activity could be detected in pilot-plant runs of long duration during those periods when hydrogen sulfide was present in the recycle gas.

**TABLE 2**

**Effect of Hydrogen Sulfide in Recycle Gas**

**Feed Stock: Middle East light catalytically cracked cycle oil.**

| | | | | |
|---|---|---|---|---|
| ASTM boiling range, fahrenheit | 460 to 640 | | | |
| Gravity, API | 21 | | | |
| Sulfur, percent by weight | 3.1 | | | |
| **Plant:** | | | | |
| Reactor | 3-in. | | | |
| Catalyst-bed height | 18 ft. | | | |
| **Processing Conditions:** | | | | |
| Pressure, psia | 750 | .... | .... | .... |
| Temperature, fahrenheit | 708 | .... | .... | .... |
| Liquid hourly space velocity, volumes per volume per hour | 2.2 | 2.2 | 1.1 | 1.1 |
| Recycle-gas rate, scf per barrel | 270 | 270 | 1350 | 1350 |
| Hydrogen-sulfide removal from recycle gas | Yes | No | Yes | No |
| Sulfur removal, percent | 86 | 86 | 95 | 94 |

The removal of hydrogen sulfide from the recycle gas can, therefore, be omitted in this trickle process—the hydrogen sulfide produced leaving the system with the liquid product from which it is removed by flashing. This again leads to a significant saving in capital and operating costs, particularly in refineries where no removal of hydrogen sulfide from the tail gas is necessary, or where the relatively small quantity of tail gas can be routed to an existing plant for hydrogen-sulfide removal.

### Operating Pressure and Temperature

The process can be operated at pressures ranging from 300 to 750 psia, and at temperatures from 660 to 730 F. The preferred conditions for deep desulfurization (80 to 90 per cent sulfur removal) from middle distillates are at pressures from 600 to 750 psia and at temperatures from 690 to 720 F. In pilot-plant runs of long duration, during which a number of straight-run stocks were processed under these conditions, with recycle-

gas rates of 300 to 1250 scf per barrel, no significant decrease in catalyst activity could be observed after up to 20,000 volumes of oil had passed over 1 volume of catalyst—without any intermediate regeneration. Coke deposition is practically nil, corresponding to less than 0.0005 percent by weight of oil charged. With catalytically cracked cycle stocks, the decrease in catalyst activity experienced was still very small, if any, after some 4,000 volumes of oil had passed over 1 volume of catalyst.

After this experience it was not surprising to find that, when a heavy Middle East flashed distillate was fed to the pilot plant, catalyst activity again was not reduced during a 400-hour operation. Furthermore, apart from desulfurization, in additional refining effect—consisting in a marked reduction of Conradson carbon—was observed.

It may be interesting to note that, under the conditions of the trickle-hydrodesulfurization process, sulfur and oxygen proved to be largely removed from Colorado shale oil; this was true also, although to a smaller extent, with respect to resinous materials. Nitrogen, however, was only partly hydrogenated. By increasing the pressure to 2150 psia, this deficiency could be remedied—all contaminants then being removed to the extent of 70 to 90 percent.[18]

## Effect of Diluents in Makeup Hydrogen

In view of the desirability of using impure hydrogen from catalytic reforming in the hydrodesulfurization operation, the effect of buildup of diluents (methane) in the hyrodesulfurization recycle gas has been investigated.

The decrease in degre of desulfurization was found to be small when a buildup of 15 percent by volume of methane was permitted in the recycle gas, as illustrated in Table 3. The percentage of methane which can be tolerated in the makeup hydrogen is, of course, a function of the amount of hydrogen consumed in the hydrodesulfurization reaction. When stocks with a sulfur content of, say, 1 to 1.5 percent by weight are desulfurized, makeup hydrogen with a methane content of 7 to 10 percent by volume can be used without any provisions for hydrogen concentration. If makeup hydrogen with such concentrations of methane must be used for desulfurization of higher sulfur-content stocks, the buildup of methane and other diluents in the recycle gas preferably should be depressed either with a simple concurrent oil wash or by application of a small bleed from the recycle gas.

**TABLE 3**

**Effect of Methane in Recycle Gas**

Feed Stock: Middle East light catalytically cracked cycle oil.

| | | |
|---|---|---|
| ASTM boiling range, fahrenheit | 460 to 640 | |
| Gravity, deg. API | 21 | |
| Sulfur, percent by weight | 3.1 | |
| **Plant:** | | |
| Reactor | 2-in. | |
| Catalyst-bed height | 6 ft. | |
| **Processing Conditions:** | | |
| Pressure, psia | 750 | |
| Temperature, fahrenheit | 708 | |
| Removal of hydrogen sulfide from recycle gas | None | |
| Liquid hourly space velocity, volumes per volume per hour | 2.2 | |
| Recycle-gas rate, scf per bbl. | 1350 | |
| Methane in feed gas, percent by volume | 0 | 3.8 |
| Methane in recyle gas, percent by volume | Negligible | 15 |
| Sulfur removal, percent | 87 | 84 |

### *Hydrogen Consumption*

From a large collection of data, it can be calculated that the hydrogen consumption in trickle hydrodesulfurization of straight-run middle distillates (boiling range, 440 to 660 F.), over a cobalt-molybdenum-alumina catalyst, amounts, on an average, to 50 scf per lb. of sulfur removed—which is equivalent to approximately 4 mols of hydrogen per atom of sulfur removed.[17] Furthermore, a slightly higher figure was found for Middle East catalytically cracked cycle oils. This is closed to the theoretical minimum of three mols per atom of sulfur removed which may be expected for hydrogenation of the sulfur compounds (alkylbenzothiophanes) which predominate in Middle East straight-run and catalytically cracked cycle oils.[5, 15] This fact confirms that the cobalt-molybdenum-alumina catalyst used possesses a satisfactory degree of selectivity under the conditions applied. Hydrogenation of aromatics is almost completely suppressed, but hydrogenation of olefins cannot be avoided entirely.

It may be of interest to note here that, for the majority of the crudes, the quantity of hydrogen produced in catalytic reforming of the naphtha cut is more than sufficient to meet the hydrogen requirements in the hydrodesulfurization of light catalytically cracked cycle oil. This hydrogen balance can even be achieved in the case of the low-naphthenic high-sulfur Middle East crudes.

### *Product Yields and Properties*

The liquid-product yields obtained are extremely high; i.e., no formation of light ends, apart from that which resulted from breakdown of sulfur compounds, could be observed. The hydrogenation of sulfur compounds results in part, in the formation of hydrocarbons boiling in the gasoline range, and the latter usually have to be removed from the desulfurized product because of their flush point. In the case of hydrodesulfurization of catalytically cracked cycle stocks, these gasoline components result from hydrogenation of alkylbenzothiophenes, and they are, therefore, of high aromatic content and octane rating.[15] This is illustrated in Table 4, which also contains some data on the properties of various cuts prepared from the desulfurized product.

The 430 to 500-F. fraction forms an excellent component for the manufacture of engine-fuel-type kerosine which, on blending with straight-run naphtha, satisfies all specifications. The 430+ or 500+ F. fractions are suitable for blending with straight-run

**TABLE 4**

**Trickle Hydrodesulfurization of Middle East Light Catalytically Cracked Cycle Oil (Product Properties)**

| | |
|---|---|
| **Processing Conditions:** | |
| Catalyst | Cobalt-molybdenum-alumina |
| Pressure, psia | 750 |
| Temperature, fahrenheit | 710 |
| Liquid hourly space velocity, volumes per volume per hour | 1.6 |
| Recycle-gas rate, scf per barrel | 1350 |

| | | PRODUCTS | | | |
|---|---|---|---|---|---|
| | Feed Stock | Fraction*: Under 430 F | Fraction*: 430 to 500 F | Fraction*: 430 F Plus | Fraction*: 500 F Plus |
| Percent by weight of feed | 100 | 9.9 | 20.3 | 87.6 | 67.3 |
| Percent by volume of feed | 100 | 10.7 | 21.3 | 90.4 | 69.1 |
| Gravity, deg. API | 21.3 | 33.8 | 25.4 | 26.1 | 25.5 |
| **ASTM Distillation (Fahrenheit):** | | | | | |
| Initial boiling point | 446 | 270 | 437 | 475 | 532 |
| End point | 650 | 417 | 480 | 650 | 650 |
| Sulfur, percent by weight | 2.90 | 0.01 | 0.02 | 0.34 | 0.43 |
| Extractable with 98-percent sulfuric acid, percent by weight | 70 | 87 | 80 | .. | .. |
| **Octane Numbers:** | | | | | |
| ASTM, without TEL addition | .. | 90 | 77 | | |
| CFR research, without TEL addition | .. | 100+ | 88 | | |
| Pour point, fahrenheit | 14 | .. | .. | 19 | 25 |
| Diesel index | 19.5 | | | 27.1 | 29.9 |

* Sharp fractionation.

gas-oil fractions into a low-sulfur high-speed diesel fuel.

It should be noted that the trends just indicated are not limited to Middle East catalytically cracked cycle oils; additional experiments with cycle oils from U. S. commercial catalytic cracking operations gave similar results—the amount of aromatic gasoline formed being roughly proportional to the sulfur content of the front end of the cycle oil.

*Commercial Application*

The trickle hydrodesulfurization process described herein is suitable for the desulfurization of a large variety of stocks. It should be noted that, inasmuch as no vaporization of the oil feed is necessary, high-boiling distillates, which would require excessive recycle-gas quantities for vaporization under the process conditions, can be desulfurized without difficulty.

Figure 1 is a simplified flow diagram of a commercial-scale unit for a trickle hydrodesulfurization of middle distillates. Such a unit is now under construction at the Stanlow (England) Shell Refining and Marketing Company, Ltd. Oil charge and fresh hydrogen, as well as recycle hydrogen, are combined. The combination is first preheated by exchange with hot reaction products, and then is heated in a small gas- or oil-fired furnace.

The reactor may contain a number of catalyst beds, between which cold charge oil is injected to take up the heat produced in the exothermic hydrogenation reaction. The number of beds required depends upon the sulfur content of the charge stock and upon the degree of sulfur removal desired. With low-sulfur stocks, i.e., stocks with a sulfur content of, say, approximately 1 percent by weight or less, intermediate cooling may be omitted. The reaction products, after heat exchange with the feed, are cooled further and then passed to the high-pressure separator—from which, after the addition of makeup hydrogen, the gas is recycled. The liquid from the high-pressure separator is flashed in a low-pressure separator, and is then passed to a product fractionating section for removal of the remaining hydrogen sulfide and light ends.

If desired, an engine-fuel type of kerosine component may be recovered. The low-pressure tail gas is, if desired, passed to a gas-purification plant for removal of hydrogen sulfide; and the latter may, for example, subsequently be converted to sulfur in a Claus plant.

For most commercial applications the rate of decrease of catalyst activity will be extremely low, corresponding to a catalyst "life" on the order of one year. Catalyst activity can be restored completely by regeneration *in situ*.

*Economics*

Obviously, the economics of an "upgrading" operation such as the hydrodesulfurization of straight-run gas oil of light catalytically cracked cycle gas are in large measure dependent upon local conditions, such as, for example, the availability of low-cost hydrogen and the crudes processed. Therefore, Table 5 may suffice to indicate the cost of trickle hydrodesulfurization operation in two typical cases.

**TABLE 5**
**Cost of Hydrodesulfurization**
**(Gulf Coast, U.S.A.)**

| CHARGE STOCK: | Middle East Straight-run Gas Oil | Middle East Light Catalytically Cracked Cycle Oil |
|---|---|---|
| **ASTM Distillation Fahrenheit:** | | |
| Initial boiling point | 496 | 446 |
| End point | 666 | 650 |
| Sulfur content, percent by weight | 1.3 | 2.9 |
| Sulfur removal, percent | 85 | 85 |
| Plant capacity, barrels per stream day | 10,000 | 10,000 |
| Plant investment (inside plot; including first catalyst charge, excluding process and engineering design), dollars | 930,000 | 1,300,000 |
| **Operating Cost** (excluding depreciation and interest), cents per barrel of intake: | | |
| Hydrogen[1] | 0.5 | 1.3 |
| Catalyst | 1.9 | 3.5 |
| Utilities | 1.7 | 2.5 |
| Operating labor | 2.4 | 2.4 |
| Maintenance[2] | 1.1 | 1.6 |
| Supervision and refinery Overhead[3] | 3.8 | 4.2 |
| Taxes and insurance[4] | 0.5 | 0.8 |
| | 11.9 | 16.3 |
| **Product:** | | |
| Low-sulfur diesel-fuel component, gallons per barrel of intake | 42 | 38 |
| **Byproducts:** | | |
| Heavy-gasoline component, gallons per barrel of intake | .... | 4.5 |
| Hydrogen sulfide, scf per barrel of intake | 40 | 95 |

[1] At fuel equivalent of 10 cents per million Btu's.
[2] Four percent of capital per year.
[3] Eighty percent of operating labor plus maintenance.
[4] Two percent of capital per year.


**ACKNOWLEDGMENT**

The authors wish to express their gratitude to the management of N. V. De Bataafsche Petroleum Maatschappij, The Hague, for permission to publish this paper.

The experimental work was carried out by the development and pilot-plant staff of the Royal Dutch Shell Laboratory, Amsterdam, under the daily supervision of W. F. Engel, J. Koome, and K. A. Weeda; and, in the latter stages, it was directed by J. Verheus, to whom the authors are greatly indebted. Discussions with P. van 't Spijker of Bataafsche Petroleum Maatschappij, The Hague, and with A. H. Boultbee of Shell Refining and Marketing Company, Ltd., London, furnished great stimulus throughout the work.


**REFERENCES**


[1] H. M. Smith and O. C. Blade, *Oil Gas J.* **46 [30]** 73 (1947).

[2] H. M. Smith, *Proc. Third World Petroleum Congress, The Hague, 1951*, Sect. VI, 319, E. J. Brill (Leiden, THE NETHERLANDS) (1951).

[3(a)] L. C. Strang, *Inst. Petroleum Ref.* **2**, 123 (1948).

[3(b)] O. C. Blade, E. L. Garton, and C. M. McKinney, *U. S. Bur. Mines Rept. Invest. 4657* (1950).

[4] J. J. Broeze and A. Wilson, *Proc. Inst. Mech. Engrs. (London) Automobile Div.*, 128 (1941-49).

[5] O. C. Blade, *U. S. Bur. Mines Rept. Invest. 4746* (1950) and *U. S. Bur. Mines Rept. Invest. 4830* (1951).

[6] W. P. Gee, H. H. Gross, and W. E. Skelton, *Proc. Third World Petroleum Congress, The Hague, 1951*, Sect. III, 132, E. J. Brill (Leiden, THE NETHERLANDS) (1951).

[7] A. P. Lien, D. A. McCaulay, and B. L. Evering, *Proc. Third World Petroleum Congress, The Hague, 1951*, Sect. III, 145, E. J. Brill (Leiden, THE NETHERLANDS) (1951).

[8] C. L. Brown, Alexis Voorhies, Jr., and W. M. Smith, *Ind. Eng. Chem.* **38 [2]** 136 (1946).

[9] Alexis Voorhies, Jr., and W. M. Smith, *Symposium on Organic Sulfur Compounds as Related to Petroleum*, 203, American Chemical Socy. Division of Petroleum Chemistry meeting, San Francisco, Calif., Mar. 27 to Apr. 1 (1949).

[10] A. C. Byrns, W. E. Bradley, and M. W. Lee, *Ind. Eng. Chem.* **35 [11]** 1160 (1943).

[11] G. W. Hendricks, H. C. Huffman, R. L. Parker, and R. I. Stirton, paper presented at the 109th meeting, American Chemical Socy., Atlantic City, N. J., Apr. 8-12 (1946).

[12] Clyde Berg, W. E. Bradley, R. I. Stirton, R. G. Fairfield, C. B. Leffert, and J. H. Ballard, *Chem. Eng. Progress (Trans. Sect.)* **43 [1]** 1-12 (1947).

[13] E. C. Hughes, H. M. Stine, and R. B. Faris, *Symposium on Organic Sulfur Compounds as Related to Petroleum*, 243, American Chemical Socy. Division of Petroleum Chemistry meeting, San Francisco, Calif., Mar. 27 to Apr. 1 (1949).

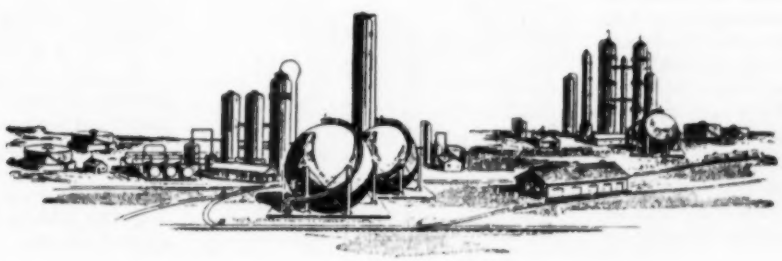
[14] Thomas Tait, *Progress in Petroleum Technology, American Chemical Socy. Advances in Chemistry Series, No. 5*, 151 (1951).

[15] H. Hoog, G. H. Reman, and W. C. Brezesinska Smithuysen, *Proc. Third World Petroleum Congress, The Hague, 1951*, Sect. IV, 282, E. J. Brill (Leiden, THE NETHERLANDS) (1951).

[16] H. Hoog, *Chemistry & Industry* **Issue No. 42**, 872-7, Oct. (1951).

[17] H. Hoog, *Rec. trav. chim.* **69 [9-10]** 1289-96 (1950).

[18] H. Hoog, J. Koome, and K. A. Weeda, *Oil Shale and Cannel Coal* **2**, 562 (1951).

# Roosevelt Oil Has First Platreater

ROOSEVELT OIL and Refining Corporation, Mount Pleasant, Mich., has the world's first Platreater, a hydrogenation process which refines aromatic concentrates prior to separation in a Udex unit.

The refinery recently installed the Platreater together with a Platforming unit and a Udex unit, all three of which were engineered and licensed by Universal Oil Products Company, Des Plaines, Ill. Procon Incorporated handled the construction of all three units, and participated in the preparation of drawings for erection of the units.

The Platformer runs for half the month on motor fuel production at a design capacity of 1800 barrels per stream day. The other half of the month is used for aromatics production, for which the Platformer is scheduled to charge 1200 barrels per stream day of feed stock, turning out in excess of 400 barrels per stream day of aromatics. In addition, the Platreater's daily output is 250 barrels of aromatics.

Roosevelt's new three-unit combination places this long-established refinery in the enviable position of being able to produce a larger quantity of premium quality gasoline, manufacture aromatics which meet the rigid nitration grade specifications with ease and to broaden its market for specialty naphthas and solvents, which for years have been the mainstay of its business.

### Michigan Crudes Used

The refinery buys aromatic distillates from chemical companies—concentrates which previously it had been unable to refine to recover pure benzene and toluene but which it used as a motor gasoline component.

Michigan crudes processed by Roosevelt contain a low percentage of naphthenes. The total amount of benzene and toluene which the Platformer alone with the Udex plant could have produced from these crudes was estimated at 180 barrels per calendar day. Of this amount, 140 barrels per calendar day would have been toluene.

The aromatic distillates—a by-product of ethylene production by high severity thermal cracking—contain recoverable benzene and toluene estimated at about 250 barrels per calendar day. But they also contain a wide variety of unsaturates, chiefly olefins which make up 38 percent of the concentrates.

Hydrogenation of the olefins and destruction of sulfur compounds facilitates operation of the Udex unit for high quality aromatic products. Universal's scientists and engineers created the Platreater to do this job. The product issuing from the Platreater has been found to be a good feed for recovery of aromatics, and gives the refinery a supplemental supply of benzene and toluene to those obtained from the Platformer.

### Continuous Run

Excess hydrogen from the Platformer, produced either in the motor fuel or aromatics runs, is cycled through the Platreater to saturate the olefins into paraffins before charging to the Udex unit. The constant supply of hydrogen enables the Platreater to be run continuously.

The distillates used in the Platreater are delivered to Roosevelt by truck, then pumped from storage to a prefractionator. Here a sidecut which constitutes the Platreater charge is made. The sidecut is mixed directly with a gas stream and then preheated through heat exchangers, from whence the combined feed enters a catalytic reactor where contact is made with the Platreater catalyst.

**Udex Unit Feed and Products**

| | Feed | Raffinate | Benzene Product | Toluene Product |
|---|---|---|---|---|
| Benzene, Wt., percent | 15.3 | 0.0 | .... | .... |
| Toluene, Wt., percent | 22.6 | 0.7 | .... | .... |
| Boiling Range, ASTM D-835-47, °C. | .... | .... | 0.9 | 1.0 |
| Acid Wash Color | .... | .... | +1 | 0 |
| Freezing Point, °C | .... | .... | +5.3 | .... |
| Gravity, °API | 58.0 | 76.7 | .... | .... |
| **ASTM Distillation, °F.** | | | | |
| IBP | 146 | 144 | .... | .... |
| 5 percent | 163 | 150 | .... | .... |
| 10 percent | 164 | 152 | .... | .... |
| 30 percent | 170 | 158 | .... | .... |
| **50 percent** | **179** | **164** | .... | .... |
| 70 percent | 193 | 174 | .... | .... |
| 90 percent | 222 | 194 | .... | .... |
| 95 percent | 237 | 206 | .... | .... |
| EP | 272 | 274 | .... | .... |
| Percent Recovered | 98.5 | 99.0 | .... | .... |
| Percent Bottom | 1.0 | 0.5 | .... | .... |
| Percent Low | 0.5 | 0.5 | .... | .... |

After passing through the reactor, the product is sent to a cooler, then to a separator. The liquid from the separator is charged to a stabilizer column, where the stock is stabilized to $C_6$ and heavier bottoms. The bottoms are sent to the Udex charge tanks, which also contain the product of the Platformer's benzene-toluene operation. These two products combine to create feed stock for the Udex unit.

Feed stock from the Udex charge tanks is pumped into an extractor, where it is contacted with the solvent which contains diethylene glycol, which removes aromatics from the feed stock. Non-aromatic raffinate from the Udex plant passes out of the extractor through a water wash to storage.

Solvent containing extracted aromatics passes into a solvent stripping column, where aromatics are recovered. In subsequent operations, the aromatics pass through a water wash and a clay treater before going into intermediate tankage.

Feed stock for the benzene-toluene fractionators is pumped from the intermediate storage into the benzene column, where benzene is taken as an overhead product. Bottoms from the benzene column pass into the toluene column for recovery of this aromatic as overhead product.

Platformer feed stock for the benzene-toluene operation has a boiling range of about 150 to 225 F. For the motor fuel operation, materials of a boiling range of 225 to 400 F. are used.

### 7000 Barrels Daily

Roosevelt is processing 7000 barrels of Michigan crude a day. In the motor fuel operations, a stabilized Platformate having a leaded F-1 octane number of 92 to 94 is being produced.

Roosevelt is experiencing an increasing demand from the solvent industry for aromatic-free naphthas. The refinery therefore plans to supply the non-aromatic residue from the Udex plant to the trade as a specialty product, thus adding to its present line of special solvents.

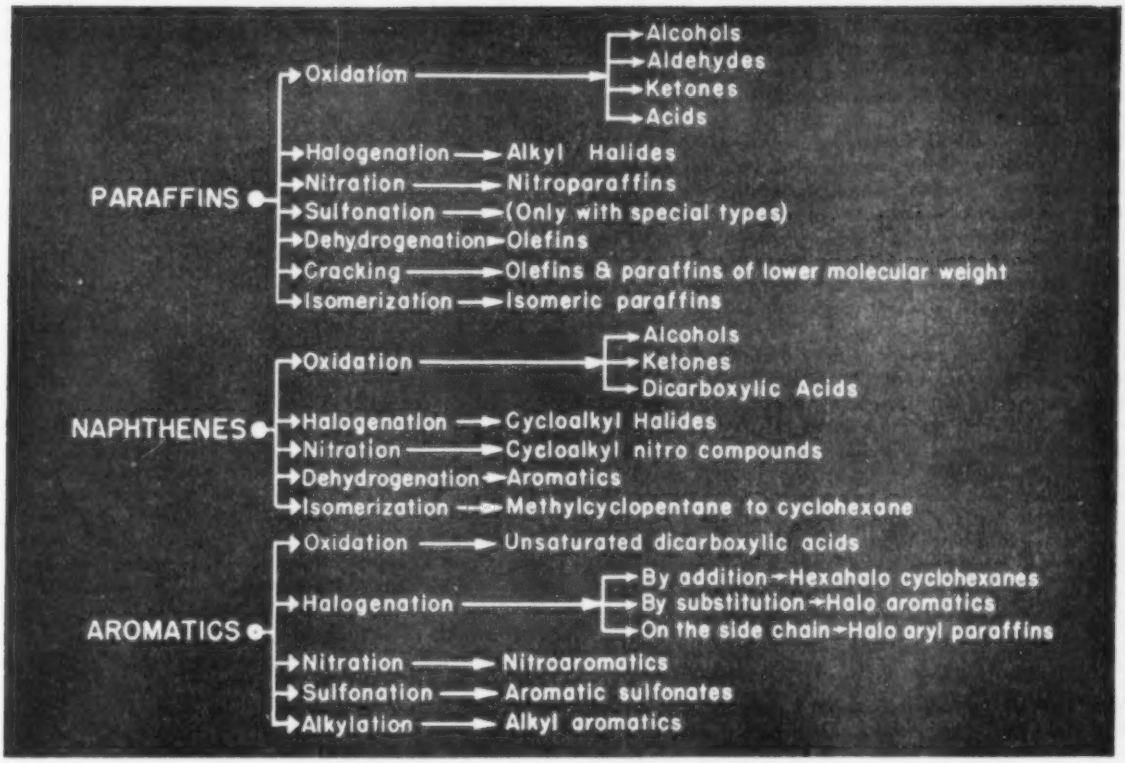



Table 1. Reactions of the Paraffins, Naphthenes and Aromatic Hydrocarbons

*Understanding the Chemistry of . . . .*

# . . . Petrochemical Reactions

## Part I. Petroleum as a raw material for the chemical industry

**Lewis F. Hatch,** University of Texas, Austin

THE TERM "petrochemicals" has at one time or another meant all things to all men. For our purposes we will consider a petrochemical any chemical compound obtained directly from petroleum or natural gas or derived from petroleum or natural gas hydrocarbons. The present series of articles will deal primarily with the nature of the raw material, petroleum and natural gas, and with the fundamental chemical changes which may be used on compounds from these sources to prepare material to be utilized in chemical markets.

The interest in petrochemicals by the petroleum industry is amply shown by the large number of general articles appearing in current magazines. These articles usually point out the magnitude of the petrochemical industry, and the figures are impressive. Petrochemicals comprise about 25 percent of all United States production of chemicals and have a value of $1.6 billion. There are more than 70 oil and chemical companies operating 130 petrochemical plants with a total investment of about $2 billion. Fifty of these plants are located in the Texas-Louisiana Gulf Coast area and account for about 85 percent of the annual production. At present less than half of all petrochemical companies are owned and operated by petroleum companies.

A plot of the remarkable increase in production of petrochemicals within the last ten years predicts a doubling of the present production in the next ten years. Petrochemicals is a big baby now and, as any proud parent would, we are going to look into its heredity and its potentials for the future. It will not be the purpose of these articles to record the daily activities of petrochemicals or even to note specifically each pound added or inch grown. The emphasis will be on the basic chemistry behind the production figures. Current data are always available in the many general articles on petrochemicals appearing in

current technical magazines. In fact, it would appear that most of these magazines would feel less than completely dressed without at least one such paper every month. It is even thought that the petroleum industry would rather be caught with their plants down than be without the latest on petrochemicals.

The interest of the petroleum industry in petrochemicals comes naturally not only because the industry provides the raw material but also because petrochemicals may provide a profitable subsidiary business without dislocating the flow of petroleum to the industries main products. At present only 0.7 percent of petroleum output goes into making the tremendous dollar volume of petrochemicals. The most optimistic planner envisions only 2.0 percent being used for this purpose by 1975.

This ever-increasing production of petrochemicals is not alone the result of an increasing demand by the chemical markets, especially plastics and synthetic detergents (syndets). The ability of the industry to supply the individual compounds desired is also a major factor. The problem of separating individual compounds from natural gas is not great for most natural gas contains between 85 and 95 percent methane ($CH_4$), 5 and 10 percent ethane ($CH_3CH_3$), and lesser amounts of higher molecular weight paraffin hydrocarbons (propane, $CH_3CH_2CH_3$; and the butanes, $CH_3CH_2CH_2CH_3$, $CH_3CH(CH_3)CH_3$ for example). Crude oil, on the other hand, is much more complex.

## What Is the Composition of Crude Oil?

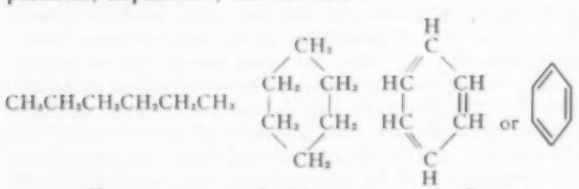
Most uses of petroleum involve a complex mixture of compounds which are at best only roughly separated by distillation. "Crude oil assay" which estimates accurately the maximum and minimum yields of gasoline, kerosine, light gas oil, lubricating oil or heavy gas oil and reduced crude is adequate for this type of use. To estimate the potentials of petroleum as a source of individual compounds for the chemical industry requires a more detailed assay, one which gives data both in respect to the individual compounds and to the hydrocarbon types. This is not easy, for petroleum is not only a complex mixture of hydrocarbons of three different types but also contains compounds of oxygen, nitrogen and sulfur. The relative amounts of these nonhydrocarbon compounds can be estimated from elemental analysis.

**Elemental Analysis of Petroleum**

| Element | Percent, Range |
|---|---|
| Carbon, C | 83–87 |
| Hydrogen, H | 11–15 |
| Sulfur, S | 0– 6 |
| Oxygen, O | 0– 2 |
| Nitrogen, N | 0– 0.5 |
| Metallic | 0– 0.1 |

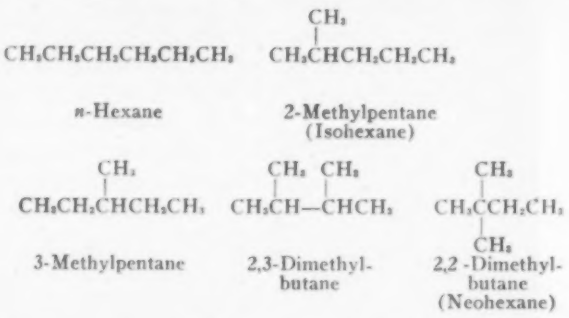
Elemental analysis can be deceptive. The analysis above shows only a small percentage of O, N, and S present, but, when evaluated as compounds, the percentage is much higher. In high sulfur crudes as much as 50 percent of the compounds may contain sulfur.

The hydrocarbons in petroleum are of three types: paraffins, naphthenes, and aromatic.



Hexane — A paraffin; Cyclohexane — A naphthene; Benzene — An aromatic

The number of compounds possible of each type is very large. There are five different paraffin hydrocarbons having six carbon atoms



*n*-Hexane; 2-Methylpentane (Isohexane); 3-Methylpentane; 2,3-Dimethylbutane; 2,2-Dimethylbutane (Neohexane)

These compounds are isomers and have essentially the same chemical properties but somewhat different physical properties. There are 35 different paraffin hydrocarbons of nine carbon atoms, 4347 with 15 carbon atoms and more than 36 million having 25 carbon atoms. The same figures apply to a lesser extent to the other two hydrocarbon types. In addition there are compounds of mixed types such as a benzene with a naphthenic ring attached. Fortunately petroleum actually contains only a relatively few of the many possible hydrocarbons.

Each crude oil has a different composition, but it is possible to make some generalizations in respect to the types of hydrocarbons present. The relative amounts of paraffins and naphthenes in the 120-214 F., range of three crudes (Bradford, Pa.; Ponca City, Okla.; East Texas) are 67 percent paraffins, 33 percent naphthenes; 56 percent paraffins, 44 percent naphthenes and 52 percent paraffins and 48 percent naphthenes. The paraffins consist mainly (49, 69 and 50 percent) of normal paraffins and monomethyl paraffins (46, 27 and 44 percent). More highly branched paraffins made up the remainder. A study by the Standard Oil Development Company of individual compounds in East Texas crude boiling above 214 F., indicated the following distribution of paraffin isomers in the $C_8$ range.

| | |
|---|---|
| Straight chain | 44.7 percent |
| Monomethyl | 41.3 percent |
| Dimethyl | 10.5 percent |
| Ethyl | 1.7 percent |
| Trimethyl | 0.9 percent |
| Methylethyl | 0.9 percent |

The percentages of $C_8$ naphthenes showed a greater percent of cyclohexanes (66.5 percent) than cyclopentanes (33.5 percent) with the dimethyl naphthenes predominating over the ethyl, methylethyl and propyl naphthenes.

Although aromatics are present in petroleum in relatively small amounts, all 14 of the aromatic compounds boiling between 176 and 337 F., have been isolated from petroleum. Toluene is present in larger amounts than benzene, and, as in the case of the naphthenes, compounds with ethyl, propyl and higher side chains are present in smaller amounts than those with only methyl groups attached.

More than 100 different compounds have been isolated from Ponca City crude oil over a period of years in a research project sponsored by the American Petroleum Institute. These compounds account for more than 40 percent of the total crude which indicates that, although petroleum is complex, it is not as bad as it might be. Commercially it is feasible to separate hydrocarbons containing at least eight carbon atoms. This includes most of the compounds actually or potentially of interest in petrochemicals.

## How Are the Compounds Separated?

Several different methods are used to effect these separations. The following are commonly used by industry and in the laboratory.

I. Distillation
  1. At one fixed pressure
    a. Makes separation based on molecular size
  2. Alternately at two fixed pressures
    a. Will separate molecular types
  3. With an azeotrope-forming substance
    a. Will separate molecular types

II. Extraction
  1. With different solvents
    a. Will separate molecular types
  2. At different temperatures
    a. Will separate molecular types

III. Adsorption
  1. With different adsorbents
    a. Will separate molecular types
  2. At different temperatures
    a. Will separate molecular types

IV. Crystalization
  1. From the mixture of hydrocarbons
    a. At a given molecular weight the freezing point usually increases with an increase in the symmetry of the molecule.
    b. With a given degree of symmetry the freezing point increases with increase in molecular weight.
  2. From a solution of the hydrocarbons in an appropriate solvent.
  3. Extractive crystallization
    a. Urea will separate straight chain paraffin hydrocarbons from other hydrocarbons.
    b. Thiourea will separate isoparaffin hydrocarbons from other hydrocarbons.

## What Are Some of the Basic Reactions?

The hydrocarbons are characterized by their resistance to chemical action. The name paraffin is derived from the Latin *parvum affinis*, which means "little affinity" and is a fairly accurate commentary on the chemical reactivity of these compounds. The naphthenes and aromatic hydrocarbons are only slightly more reactive.

The principal reactions of these hydrocarbons are given in Figure 1, along with the type of compound formed. Each type of reaction requires a relatively high temperature, at least for the paraffin hydrocarbons, and usually results in a number of products.

Dehydrogenation and cracking are the most important reactions of paraffin hydrocarbons, for they give rise to olefins. Olefins are unsaturated hydrocarbons (for example, propylene $CH_3CH=CH_2$) which are more reactive than paraffin hydrocarbons, and most of the petrochemicals come from them (alcohols, glycols, alkylated benzenes, etc.). Celanese Corporation of America has two plants in Texas which oxidize propane and butane to obtain predominantly acetaldehyde and acetic acid; methane is oxidized to formaldehyde by several companies. The halogenation of the higher hydrocarbons is carried out by only one company, Sharples Chemicals, Inc. They chlorinate a mixture of pentanes to a mixture of pentyl chlorides. The

Chlorination $\underset{\text{Pentane}}{C_5H_{12}} + Cl_2 \rightarrow \underset{\text{Pentyl chlorides}}{C_5H_{11}Cl} + HCl$

chlorides are subsequently hydrolyzed to produce Pentasol solvent. Methane, and, to a lesser extent, ethane are chlorinated by several different companies.

Commercial Solvents is the only company nitrating paraffin hydrocarbons. The multiplicity of products makes this a not too promising method of ultilizing paraffin

Nitration $\underset{\text{Propane}}{CH_3CH_2CH_3} + HNO_3 \rightarrow \underset{\text{1-Nitropropane}}{CH_3CH_2CH_2NO_2} +$

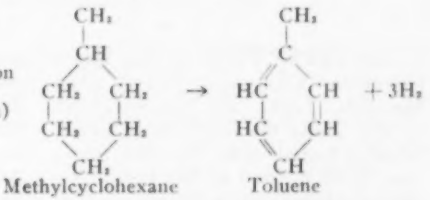
$\underset{\text{2-Nitropropane}}{CH_3CHNO_2CH_3} + \underset{\text{Nitroethane}}{CH_3CH_2NO_2} + \underset{\text{Nitromethane}}{CH_3NO_2}$

hydrocarbons. Isomerization is a more important reaction with butane than with any of the other paraffins—at least as far as petrochemicals is concerned.

Isomerization $CH_3CH_2CH_2CH_3 \rightleftharpoons CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$

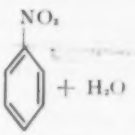
The naphthenes will undergo all of the general reactions of paraffins, although not a great deal of work has been done with this type of hydrocarbon. Most of the research has been on cyclopentane and cyclohexane. The dehydrogenation of cyclohexane to benzene and methylcyclohexane to toluene are reactions of great importance.

Dehydrogenation (Aromatization)

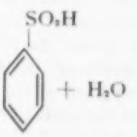


Methylcyclohexane → Toluene + $3H_2$

Aromatic hydrocarbons nitrate and sulfonate much more readily than either paraffins or naphthenes and give a good yield of the mono derivative.

Nitration $HNO_3 \rightarrow$  $+ H_2O$

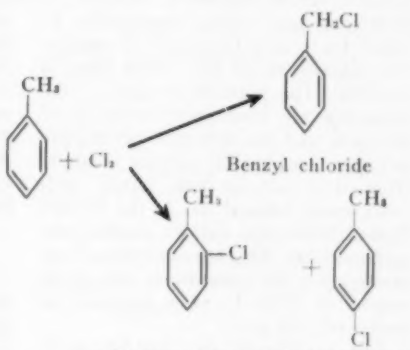
Nitrobenzene

Sulfonation $H_2SO_4 \rightarrow$  $+ H_2O$

Benzenesulfonic acid

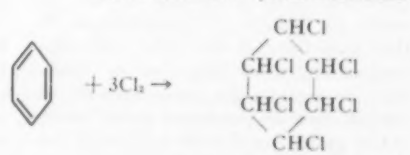
They also halogenate by substitution on the ring or side chain or by addition depending upon external conditions.

Chlorination by Substitution



Benzyl chloride; *o*-Chlorotoluene; *p*-Chlorotoluene

Chlorination by Addition



Hexachlorocyclohexane **(BHC)**

These and other reactions will be discussed in detail in subsequent issues.

# Grace Chemical Venture Based on These Processes:

## • Texaco's Partial Oxidation

## • Casale Ammonia

## • Pechiney Urea

CONSTRUCTION of the Grace Chemical Company plant near Memphis, Tenn., will get underway in May under the direction of Foster Wheeler Corporation. The three processes to be utilized in this new petrochemical plant will be Texaco's partial oxidation, Casale, and Pechiney. The plant is scheduled to go on stream in the summer of 1954.

Grace Chemical's plant will employ an air separation plant to furnish pure oxygen and nitrogen; the Texaco partial oxidation process for the manufacture of synthesis gas; the Casale ammonia process for the production of ammonia; and the Pechiney process for the manufacture of urea by use of by-product carbon dioxide and ammonia from the Casale unit. Nitrogen produced in the form of ammonia and urea at the Grace Chemical plant will be used by both agriculture and industry.

The Texaco partial oxidation process is unique in that it uses natural gas and oxygen, partially burning these at intermediate pressure and high temperature to obtain a mixture of hydrogen and carbon monoxide. In order for Grace Chemical to employ this process, an air separation plant is essential. The plant will separate the incoming air into pure fractions of nitrogen and oxygen and an impure nitrogen stream. The oxygen obtained from this unit is then mixed with compressed natural gas in the Texaco Partial Oxidation unit to produce the synthesis gas. The temperature of operation for the generators will be in excess of 2000 F. at a pressure in excess of 300 psi.

The synthesis gas produced is quenched with a recycle stream of water to reduce the temperature. It then goes through the usual shift conversion and monoethanolamine scrubbing to remove the large amount of carbon dioxide produced in the shifting of carbon monoxide to dioxide for the additional production of hydrogen. The synthesis gas leaving the monoethanolamine absorber contains small quantities of carbon monoxide, argon, and other small impurities. In order to obtain a synthesis gas of very high purity, the gas then is subjected to a liquid nitrogen wash system in which the pre-cooled gas meets a stream of liquid nitrogen in a bubble-cap tower. Any impurities that have not condensed in the pre-cooling stage will be condensed in the tower and thereby removed from the synthesis gas.

After final purification in the liquid nitrogen wash tower, the synthesis gas is then compressed to the operating pressure of the Casale ammonia system which is 8000 to 12,000 psi.

The Casale Ammonia System is unique in that it uses an ejector for the recirculation of non-converted gases, rather than the more common compressor. Otherwise, the Casale system is quite similar to the standard ammonia process. One of the great advantages gained by the use of high pressure in the synthesis is that ammonia condensation can be brought about at the usual cooling water temperatures rather than the low temperatures obtained by ammonia refrigeration. Since very pure synthesis gas will be used for the ammonia synthesis, a long catalyst life and high conversion per pass is expected. The Casale ammonia plant is designed for a capacity of 250 tons per operating day, and it is expected that the plant will produce somewhat more. A portion of this ammonia will be used directly in the manufacture of urea by the Pechiney process.

### Pechiney Urea Synthesis

The urea plant uses purified carbon dioxide and ammonia as the raw materials. The purified carbon dioxide is obtained in the raw form from the monoethanolamine stripper and is then compressed and purified to remove traces of sulphur and oxygen. The individual feed streams are pre-heated and then forced into a high pressure autoclave to which a recycle ammonium carbamate-oil slurry also is added. The conversion of ammonia and carbon dioxide to ammonium carbamate is complete. However, the conversion of ammonium carbamate to urea is an equilibrium reaction and therefore not complete. However, it is expected that equilibrium will be reached. The material, as it leaves the autoclave, is reduced in pressure and some of the ammonium carbamate decomposes into ammonia and carbon dioxide. The mass from the autoclave goes into a stripper where all of the ammonium carbamate is decomposed into carbon dioxide and ammonia to be recycled to the autoclave. The bottoms of the stripper which contain urea, water and oil are then fed to a decanter where the oil separates, giving a lower layer of urea in water solution.

The oil is passed through Pechiney's "salt oil reactors" in which the recycle ammonia and carbon dioxide is absorbed in the oil, forming ammonium carbamate in a crystalline form. This oil slurry containing the ammonium carbamate then is recycled to the autoclave for further conversion. The urea in water slurry obtained from the decanter can be processed in two steps. First, it is purified to remove any metal impurities, and it will then be crystallized to give technical grade and feed grade urea, while a portion of the purified material will be evaporated directly and prilled to give fertilizer grade urea. The urea produced in this manner will meet all the necessary specifications for technical grade.

The advantages of the Pechiney system are that the carbon dioxide and ammonia which are obtained on the break-up of the ammonium carbamate can be recirculated in the ammonium carbamate form. Other processes either have to separate the carbon dioxide and ammonia completely before compression in order to avoid ammonium carbamate formation in the compressor cylinders, or the combined recycle of ammonia and carbon dioxide is absorbed in water and then returned to the autoclave. The advantage of the Pechiney Process over the latter is the fact that no water is required for the recirculation of the gases and thereby a high conversion efficiency is obtained in the autoclave, without any excess of ammonia.

I HAVE OFTEN BEEN IMPRESSED by the scanty attention paid even by original workers in physics to the great principle of similitude. It happens not infrequently that results in the form of "laws" are put forward as novelties on the basis of elaborate experiments, which might have been predicted a priori after a few minutes' consideration. However useful verification may be, whether to solve doubts or to exercise students, this seems to be an inversion of the natural order. One reason for the neglect of the principle may be that, at least in its applications to particular cases, it does not much interest mathematicians. On the other hand, engineers, who might make much more use of it than they have done, employ a notation which tends to obscure it. I refer to the manner in which gravity is treated. When the question under consideration depends essentially upon gravity, the symbol of gravity (g) makes no appearance, but when gravity does not enter into the question at all, g obtrudes itself conspicuously.

Lord Rayleigh[12]

# Learning How to Use Dimensional Analysis

## Part II. The correct use of dimensional systems

**Homogeneity is presented as the basis of dimensional analysis**

**I. H. Silberberg[1] and J. J. McKetta, Jr.[2]**

IN PART I,* the absolute, gravitational, and engineering systems of dimensions were developed from Newton's equation of motion. Although these systems are the ones most commonly used in scientific and engineering work, they are by no means the only systems possible. In the same manner that the three common systems were developed from Newton's law, other systems may be developed from fundamental physical equations and definitions. The only requirements on such a dimensional system are that it be completely capable of describing dimensionally all of the quantities involved and that it permit the use of units that may be related to the established standard units. Subject to these limitations, the selection of certain dimensions as primary and the remaining dimensions as secondary is not restricted by natural conditions but may to a large extent be arbitrary. In fact, convenience may be the determining factor in the choice of primary and secondary dimensions.

The correct use of a dimensional system requires the proper expression of the dimensions of all the quantities involved in terms of the primary dimensions of that system. In addition, and of equal importance is the requirement that, if the system involves specially defined units of measurement, these units and no others must be used. If certain dimensional constants, such as $g_c$ or J (the mechanical equivalent of heat) are necessitated by the dimensional system used, these must also be taken into proper consideration. The last and most obvious condition is that the dimensional system to be used must be capable of describing dimensionally all of the quantities involved in the problem.

The three dimensional systems with which the engineer is most frequently in contact are the absolute, gravitational, and engineering systems. The absolute system is most commonly used in physics. The gravitational system is used in various fields of engineering. The engineering system is commonly employed in chemical and petroleum engineering and in engineering thermodynamics.

In addition to the primary dimensions determined on the basis of Newton's law of motion, all three of these systems also employ temperature (symbol, T) as a primary dimension. The main features of these systems are summarized in Table 1. The dimensions of some common engineering quantities in the three systems are given in Table 2. The following example illustrates how secondary dimensions may be expressed in terms of the primary dimensions of each system.

### Example 1.
### Expression in Terms of Primary Dimensions

(a) Energy E is defined as the product of a force and a distance.

$$E = FL$$

(1) Absolute System: $F = ML/\theta^2$ (Force is secondary.)

$$\therefore E = (ML/\theta^2)(L) = ML^2/\theta^2$$

(2) Gravitational System: $E = FL$

(3) Engineering System: $E = FL$

(b) Absolute viscosity, $\mu$, is defined by saying the shearing force is proportional to the velocity gradient, or mathematically:

$$\text{Shearing Force} = \mu(\text{Velocity Gradient})$$

$$\text{or } \mu = \left[\frac{\text{Force}}{\text{Area}}\right]\left[\frac{dx}{dV}\right]$$

**TABLE 1**
**Characteristics of Absolute, Gravitational and Engineering Systems**

| SYSTEM | Primary Dimensions | Units of Force | Units of Mass |
|---|---|---|---|
| Absolute | MLθT | Poundal, Dyne, Newton | Pound, Gram, Kilogram |
| Gravitational | FLθT | Pound, Kilogram | Slug, $\frac{\text{Kilogram-sec.}^2}{\text{Meter}}$ |
| Engineering | FMLθT | Pound | Pound |

[1] Phillips Petroleum Company Research Fellow in Chemical Engineering, The University of Texas.
[2] Editorial Director, *Petroleum Refiner*.
* *Petroleum Refiner*, 32, 179-83 (April, 1953).

**TABLE 2**

**Some Quantities and Their Dimensions in Three Systems**

| Name of System | Absolute | Gravitational | Engineering |
|---|---|---|---|
| Primary Dimensions | M,L,Θ,T | F,L,Θ,T | F,M,L,Θ,T |
| Length | L | L | L |
| Time | Θ | Θ | Θ |
| Mass | M | FΘ²/L | M |
| Force | ML/Θ² | F | F |
| g, Newton's Constant | None | None | ML/FΘ² |
| Pressure (p) | M/LΘ² | F/L² | F/L² |
| Mass Velocity (G) | M/L²Θ | FΘ/L² | M/L²Θ |
| Linear Velocity (V) | L/Θ | L/Θ | L/Θ |
| Linear Accelleration (a) | L/Θ² | L/Θ² | L/Θ² |
| Linear Momentum | ML/Θ | FΘ | ML/Θ |
| Angular Velocity | 1/Θ | 1/Θ | 1/Θ |
| Angular Acceleration | 1/Θ² | 1/Θ² | 1/Θ² |
| Angular Momentum | ML²/Θ | FLΘ | ML²/Θ |
| Energy, Work (E) | ML²/Θ² | FL | FL |
| Energy/Unit Mass | L²/Θ² | L²/Θ² | FL/M |
| Power | ML²/Θ³ | FL/Θ | FL/Θ |
| Density (ρ) | M/L³ | FΘ²/L⁴ | M/L³ |
| Surface Tension (σ) | M/Θ² | F/L | F/L |
| Absolute Viscosity (μ′) | ..... | FΘ/L² | FΘ/L² |
| Absolute Viscosity (μ) | M/LΘ | ..... | M/LΘ |
| Kinematic Viscosity (μ/ρ) | L²/Θ | ..... | L²/Θ |
| Specific Heat (C) | L²/Θ²T | L²/Θ²T | FL/MT |
| Thermal Conductivity (k) | ML/Θ³T | F/ΘT | F/ΘT |
| Heat Transfer Film Coeff. (h) | M/Θ³T | F/LΘT | F/LΘT |

Dimensionally, $\mu = \left[\frac{F}{L^2}\right]\left[\frac{L}{L/\Theta}\right] = \frac{F\Theta}{L^2}$

(1) Absolute System: $F = ML/\Theta^2$ (Force is secondary.)

$$\therefore \mu = \frac{(ML/\Theta^2)(\Theta)}{(L^2)} = ML/\Theta$$

(2) Gravitational System: $\mu = F\Theta/L^2$

(3) Engineering System:* $\mu = F\Theta/L^2$

$$\text{or } \mu = \frac{(ML/\Theta^2)(\Theta)}{(L^2)} = ML/\Theta$$

(c) Heat capacity C is defined most simply by

$$\text{Heat Absorbed} = C(\text{Mass})(\text{Temperature Increase})$$

$$\text{or } C = \frac{(\text{Heat Absorbed})}{(\text{Mass})(\text{Temperature Increase})}$$

$$\text{Dimensionally, } C = \frac{E}{MT}$$

(1) Absolute System: $E = FL = ML^2/\Theta^2$ (Force is secondary.)

$$\therefore C = \frac{(ML^2/\Theta^2)}{(MT)} = L^2/\Theta^2T$$

(2) Gravitational System: $E = FL$; $M = F\Theta^2/L$ (Mass is secondary.)

$$\therefore C = \frac{(FL)}{(F\Theta^2/L)(T)} = L^2/\Theta^2T$$

(3) Engineering System: $E = FL$

$$\therefore C = FL/MT$$

For the proper use of dimensional systems, care should be taken to adhere to a complete system and not to mix systems. One of the greatest sources of error in this respect lies in the tendency to mix units of different systems. For example, the English system unit of mass for the gravitational system is the slug. The slug is defined as the amount of mass accelerated 1 ft./sec.² by 1 force-pound, which is in turn defined as the force which will give the standard avoirdupois pound of mass an acceleration of 32.1740 ft./sec.² Clearly the slug is 32.1740 times as large as the mass-pound. Knowledge of this relationship is useful and necessary, for example, to convert a density in pounds/cu. ft. to a density in slugs/cu. ft. However, the mass-pound is otherwise alien to the gravitational system. To speak of a mass-pound and a force-pound simultaneously implies the engineering system of dimensions, which requires the use of the dimensional constant $g_c$. Equations derived for one dimensional system are not always correct for a different system. Example 2 illustrates these points.

*Hereafter, for convenience, absolute viscosity with dimensions $M/L\Theta$ will be given the symbol $\mu$, and absolute viscosity with dimensions $F\Theta/L^2$ will be given the symbol $\mu'$. In the engineering system, $\mu = g_c\mu'$.

## Example 2.
## The Bernoulli Equation in Three Systems of Dimensions

Figure 1 illustrates the situation in which a fluid is flowing under reversible conditions in a conduit between points "1" and "2," such than no mechanical work is done. If the fluid is incompressible and the flow is isothermal, the flow equation takes on a form frequently called the Bernoulli equation. In its general form, the Bernoulli equation may be written as

$$\Delta(\text{Kinetic Energy}) + \Delta(\text{Potential Energy}) + v_m\Delta p = 0$$

The basis of each term is m units of mass; $v_m$ is the volume of m units of mass. The symbol $\Delta$ indicates the value of the property at condition "2" minus that at condition "1."

*Kinetic Energy:* When a force F is applied to a mass m through a small increment of distance ds in such a manner that only the kinetic energy of the mass is changed, the work done is equal to the change in kinetic energy, d(K.E.), of the mass.

$$d(K.E.) = Fds$$

But $F = \frac{1}{\beta}ma$, and the acceleration a may be expressed in terms of the velocity V as $a = \frac{dV}{dt} = \frac{ds}{dt}\frac{dV}{ds} = V\frac{dV}{ds}$.

Therefore, $d(K.E.) = \frac{1}{\beta}mVdV$

Integrating between the limits of velocity = $V_1$ and velocity = $V_2$, the change in kinetic energy of the mass m is expressed by the equation

$$\Delta(K.E.) = m\Delta(V^2/2\beta)$$

The difficulty in determining the true average velocity of a fluid in a conduit has no bearing on the subject here but is discussed by Dodge.[5]

*Potential Energy:* When a force F is applied to a mass m through a small increment of distance dZ in such a manner that only the potential energy of the mass relative to a reference plane is changed, the work done is equal to the change in potential energy, d(P.E.), of the mass.

$$d(P.E.) = FdZ$$

But $F = \frac{1}{\beta}ma$, and the acceleration in this case is that of gravity, g.

Therefore, $d(P.E.) = \frac{1}{\beta}mgdZ$

Integrating from $Z_1$ to $Z_2$ and assuming g to be constant, the change in potential energy of the mass m is expressed by the equation

$$\Delta(P.E.) = m\frac{g}{\beta}\Delta Z$$

Bernoulli's equation may then be expressed in the form

$$m\Delta(V^2/2\beta) + m\frac{g}{\beta}\Delta Z + v_m\Delta p = 0$$

This equation may be expressed as an energy balance per unit of mass, rather than for m units of mass, by division of each term by m. In this case, $v_m/m = v$, a specific volume.

$$\Delta(V^2/2\beta) + \frac{g}{\beta}\Delta Z + v\Delta p = 0$$

This form of Bernoulli's equation is general insofar as dimensional systems are concerned; any system may be used with it so long as $\beta$ is correctly evaluated. For the three dimensional systems being considered here, this equation takes the forms shown below.

Absolute and Gravitational Systems:

$$\Delta(V^2/2) + g\Delta Z + v\Delta p = 0$$

Engineering System:

$$\Delta(V^2/2g_c) + \frac{g}{g_c}\Delta Z + v\Delta p = 0$$

When English units are employed, $g_c = 32.1740\ \frac{(\text{mass-pounds})(\text{feet})}{(\text{force-pound})(\text{sec.})^2}$ for the engineering system equation, and the other quantities have the units presented in Table 3.

The resulting equations of Example 2 are quite similar, a fact that no doubt accounts for most of the misuse of the Bernoulli equation. The forms of the equations for the absolute and gravitational systems are identical, but the units of force and mass are different. The equation for the engineering system differs by the intrusion of $g_c$ and also by the units of force and mass required. Through the use of the dimensions given in Table. 2, it can easily be shown that the dimensions of each energy term, representing energy per unit mass, are $L^2/\Theta^2$ in both the absolute and gravitational systems and FL/M in the engineering system.

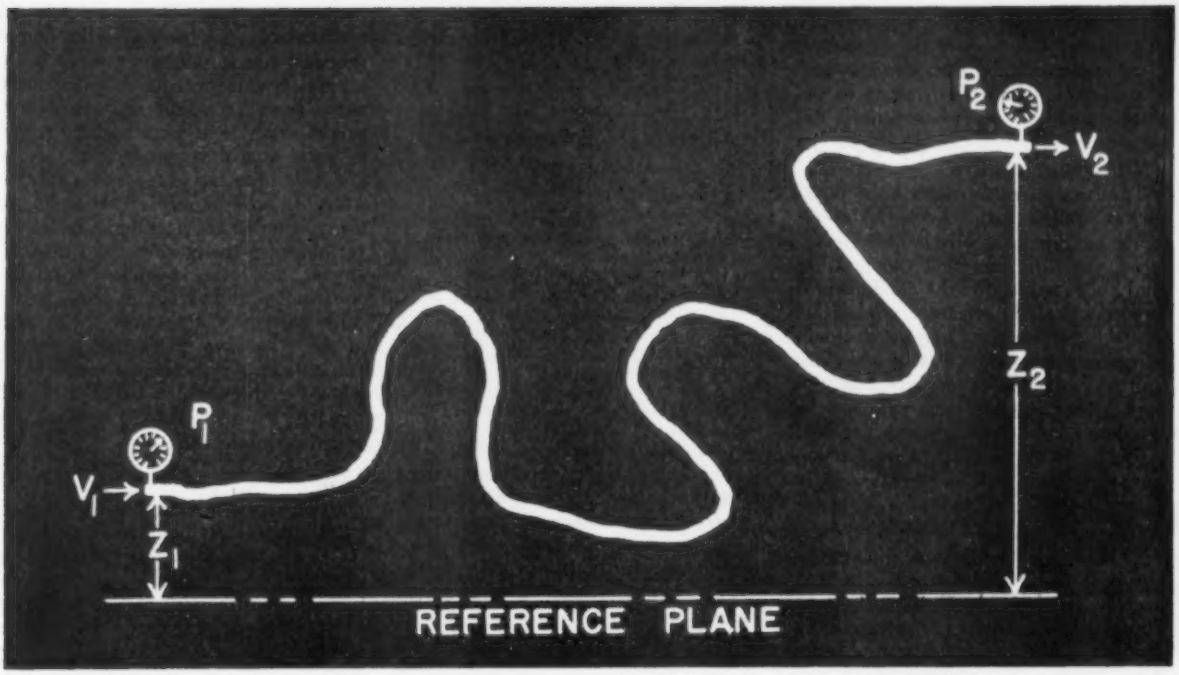



**Figure 1. A non-work flow system (Example 2).**

In English units, energy per unit mass in the absolute system has the units of $\frac{\text{(feet) (poundals)}}{\text{(pound)}}$, and in the gravitational system the units of $\frac{\text{(feet) (pounds)}}{\text{(slug)}}$.

In terms of primary units only, energy per unit mass has the units of $(\text{feet})^2/(\text{second})^2$ in both these systems. In the engineering system, the English units are $\frac{\text{(force-pounds) (feet)}}{\text{(mass-pound)}}$.

It is a common practice for engineers to refer to the terms in the Bernoulli equation as having the units of "feet of head." The peculiar use of the acceleration of gravity referred to by Lord Rayleigh[12] is coincident with the use of this concept. The Bernoulli equation is often seen written as

$$\Delta\,(V^2/2g) + \Delta Z + v\Delta p = 0$$

Although the poundal is so defined that one force-pound is equal to $g_o$ poundals, and the slug is so defined that one slug is equal to $g_o$ mass-pounds, this form of the equation may not be justified as a conversion either of poundals to force-pounds in the absolute system or of slugs to mass-pounds in the gravitational system. Force-pounds and mass-pounds are alien, respectively, to the absolute and gravitational systems. Furthermore, $g_o$ and g are not necessarily numerically equal, although their difference is usually quite small. Neither may this form of the equation be justified for the engineering system, for even though g and $g_c$ might happen to be numerically equal, they are not dimensionally equivalent, and one may not be substituted for the other in the Bernoulli equation.

However, one mass-pound does weigh (exert a force of) g poundals in the absolute system, and one slug weighs g force-pounds in the gravitational system. Furthermore, one mass-pound weighs $g/g_c$ force-pounds in the engineering system. Consequently, division of each term in the equations for the absolute and gravitational systems by g and for the engineering system by $g/g_c$ represents a conversion of the terms from a mass-basis to a *weight*-basis. The Bernoulli equation may then be correctly written for all three systems as

$$\Delta\,(V^2/2g) + \Delta Z + \frac{1}{w}v\Delta p = 0$$

where w is the *specific weight*, the weight of a unit volume. The dimensions of each term in this equation are

**TABLE 3**

| Quantity | Absolute System | Gravitational System | Engineering System |
|---|---|---|---|
| Velocity, V | Ft./sec. | Ft./sec. | Ft./sec. |
| Accel. of gravity, g | Ft./sec.$^2$ | Ft./sec.$^2$ | Ft./sec.$^2$ |
| Elevation above Reference Plane, Z | Ft. | Ft. | Ft. |
| Pressure, p | Poundals/Ft.$^2$ | Pounds/Ft.$^2$ | Force-pounds/Ft.$^2$ |
| Specific Volume, v | Ft.$^3$/pound | Ft.$^3$/Slug | Ft.$^3$/Mass-pound |

energy per unit weight, or length.

Fortunately, one unit of weight and one unit of mass usually represent very nearly the same quantity of matter in fluid flow calculations, so the numerical results from the erroneous use of the Bernoulli equation do not as a rule differ appreciably from the results of the correct use. This example does, however, serve to illustrate the importance of the correct use of dimensional systems and the possible confusion and errors that may result for the engineer who uses these systems and their units carelessly.

### Dimensional Homogeneity

An equation is said to be *dimensionally homogeneous* if each term has the same resultant dimensions. Such an equation is applicable regardless of the units used, provided that the units are compatible with the dimensional system employed with the equation. For example, for a body falling from rest in a vacuum and under the acceleration of gravity, the velocity V at time $\Theta$ is given by the equation

$$V = g\Theta$$

This equation is dimensionally homogeneous and requires two dimensions, conventionally those of length and time. The acceleration of gravity g may be expressed in feet/second,$^2$ time in seconds, and velocity in feet/second. Similarly, g may be expressed in centimeters/year,$^2$ time in years, and velocity in centimeters/year. On

the other hand, the equation

$$V = 32.2\theta$$

is not dimensionally homogeneous and is applicable within the vicinity of the earth's surface *only* when time is expressed in seconds and velocity in feet/second.

The fundamental equations of physics, and all equations derived therefrom, are dimensionally homogeneous. It is upon this fact that dimensional analysis is based, for the fundamental hypothesis of dimensional analysis is that the solution to a certain problem is expressible in the form of a dimensionally homogeneous equation involving the variables concerned in the problem. As a consequence, any sort of relation obtained through dimensional analysis will be dimensionally homogeneous.

In fact, it is the purpose of dimensional analysis to arrange the variables of a problem into sets of products which are themselves dimensionless. These dimensionless products or groups, as they are often called, may then become the arguments of any type of function, polynomial, trigonometric, or exponential, without violating the fundamental hypothesis of a dimensionally homogeneous solution to the problem.

The statement is sometimes made that all terms of a correct physical equation must have the same resultant dimensions. This is certainly true in regard to the *fundamental* physical equations and is useful in checking derivations based on these equations, regardless of the form of the equations. However, not all equations applied to physical phenomena are dimensionally homogeneous; whether such equations may be called "correct" is a moot question. One characteristic does appear to be uniformly attributable to dimensionally non-homogeneous equations, however. They are characterized by a loss either in the amount of information obtainable or in the general applicability of the equation.

If $W = X$ and $Y = Z$ are two dimensionally homogeneous equations, but such that W and Y do not have the same dimensions, the equation $W + Y = X + Z$ is not dimensionally homogeneous. It will give correct numerical results, but it will not give as much information as the two separate equations. When $X = 0$ and $Z = 0$, the combined equation tells that $W = -Y$, which is true but certainly less informative than $W = 0$ and $Y = 0$. Such a case, in which an equation is artifically and arbitrarily concocted from two other equations, need not be considered here.

Example 3 illustrates how the dimensional homogeneity of an equation may be checked.

### Example 3. Checking for Dimensional Homogeneity

In the equation

$L^3\rho^2g\lambda = \alpha k\mu\Delta t$, $\alpha$ is a dimensionless constant and

- $L$ = length
- $\rho$ = density
- $g$ = acceleration of gravity
- $\lambda$ = latent heat of evaporation per unit mass
- $k$ = thermal conductivity
- $\mu$ = absolute viscosity
- $\Delta t$ = temperature difference

For the equation to be dimensionally homogeneous, $L^3\rho^2g\lambda$ and $k\mu\Delta t$ must have the same resultant dimensions. The test may be made by substituting the dimensions of each quantity for that quantity in both terms. Using the engineering system of dimensions from Table 2,

$$L^3\rho^2g\lambda = (L)^3(M/L^3)^2(L/\theta^2)(FL/M) = \frac{FM^2L^5}{ML^3\theta^2} = \frac{FM}{L\theta^2}$$

$$k\mu\Delta t = (F/\theta T)(M/L\theta)(T) = \frac{FMT}{L\theta^2T} = \frac{FM}{L\theta^2}$$

Therefore, the equation is dimensionally homogeneous for the engineering system of dimensions. Similar tests will show that it is also homogeneous for the absolute and gravitational systems.

Dimensionally non-homogeneous equations that are not generally applicable may be divide into two types. The first type results from the insertion of a numerical value for a dimensional constant in the equation, necessitating the use of units of measurement of a definite size. The equation for the volumetric behavior of a perfect gas, $pv = 10.73T$, is correct, but only when pressure p is expressed in psia., specific volume v in cu. ft./lb. mole, and temperature T in degrees Rankine. The equation $pv = RT$, on the other hand, is general, and the numerical value of R will depend upon the units of p, v, and T used.

The second type of non-general equation results from a neglect of some of the variables that enter into the general problem. As an exaggerated example, it might be possible to obtain an equation for the pressure drop caused by friction when liquid water at 60 F. flows in a clean commercial 4-inch steel pipe. Such an equation should show that the pressure drop depended only upon the linear velocity of the water and upon the length of the pipe. The equation could not possibly be dimensionally homogeneous, but it might represent quite accurately the pressure drop for these very special conditions. Its accuracy would suffer if it were to be applied to water at a different temperature in a 4-inch pipe. It would not apply to water in any other size pipe or to many other fluids. The omission of the variables viscosity, density, pipe diameter, and pipe roughness from the equation would have made it applicable only to a situation in which each of these four variables had a certain value. It would also be the omission of these variables which made a dimensionally homogeneous form of the equation impossible.

*Know Background*

In general, any equation which is not dimensionally homogeneous should be used with caution, for the equation is restricted somehow in its application. Perhaps only certain sizes of units will give the correct numerical results, or perhaps it applies only under certain limited conditions. It is always wise to know the background of a dimensionally non-homogeneous equation before using it.

On the basis of the preceding discussion, it might be concluded that any equation which is dimensionally homogeneous consequently must include all variables and be generally applicable. This is certainly not true, and common-sense distinctions must be made. The equation for pressure drop in streamline flow will not apply in the case of turbulent flow. In many cases, it is inconvenient or even impossible to include all variables in an equation, but it may still be dimensionally homogeneous. The equation for the drag on a sphere moving through a fluid does not apply to a cylinder under the same conditions; obviously each separate geometric form would require a different equation.

For a number of years, the equation employed to calculate pressure drop for a fluid flowing in a pipe did not contain pipe-wall roughness as a variable, although the equation was dimensionally homogeneous. Inclusion of the roughness factor, although it is difficult to evaluate for a given pipe, offers an improved accuracy in pressure-drop calculations. It appears to be generally true that the greater the number of truly related variables considered in an equation, the greater is its inherent accuracy and, subject to certain obvious limitations, the more generally applicable is the equation.

**NOTE**

All literature citations appear at the end of Part I (April, 1953 issue).
Part III will appear in an early issue.

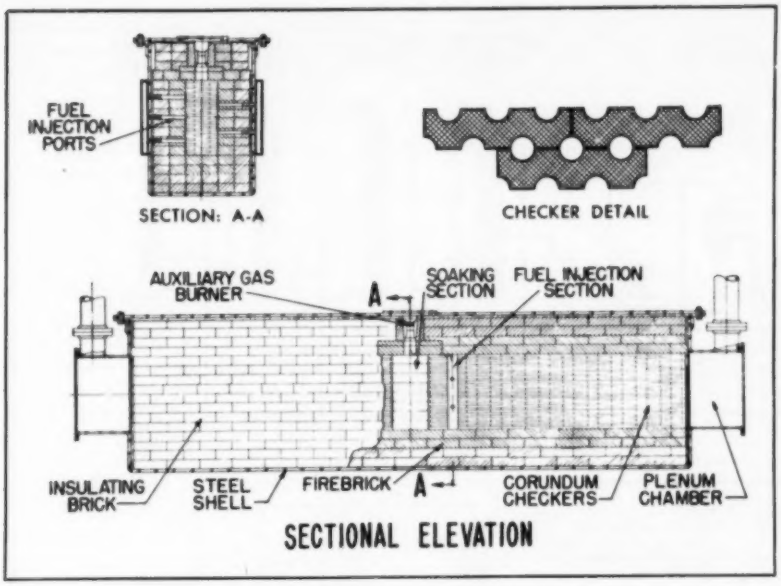



Figure 1. Wulff process cracking furnace

*Via the Wulff Process*

# What Acetylene Costs

**Cost data applied to the comparison between carbide and Wulff process acetylene for two plant locations**

**T. Weaver,**
The Fluor Corporation, Ltd.,
Los Angeles

RECENT DEVELOPMENTS now make it practical to produce large commercial quantities of acetylene by the thermal decomposition of natural gas or light hydrocarbons or both. The Wulff process described in this article is an example of such an operation.

Acetylene, if available at an attractive price, is an important raw material for the synthesis of a wide variety of useful chemicals. Until recently, all acetylene used in the United States was prepared by the classic method of mixing calcium carbide with water, and large-scale chemical applications of acetylene have been keyed to the economy of calcium carbide. Wherever possible, process units which required acetylene were located close to the areas where calcium carbide is manufactured. When acetylene was compared with other raw materials that might be used for synthesis, the comparison and selection were made on the basis of carbide acetylene.

Production from light hydrocarbons changes the economic picture of acetylene in those areas where low-cost natural gas, ethane, or propane is available. Accordingly, it is in order to consider, for those processes in which acetylene is the required raw material, the relative profitability of acetylene from carbide, and acetylene from the thermal decomposition of light hydrocarbons. Also, it is proper to re-evaluate the relative profitability of syntheses based on acetylene with those based on other competing raw materials.

A complete analysis of the relative economics of acetylene vs. a competing raw material requires cost information on:

(a) Production of acetylene by the alternative routes.
(b) Production of the competing raw material.
(c) The alternative synthesis operations.
(d) The effect of synthesis plant location on cost of raw materials and on freight costs for shipping the final product to market.

Discussed here will be basic information needed to determine the cost of producing acetylene from light hydrocarbons by the Wulff process. Additionally, as an example of the application of these data, there is presented, for two locations, an economic comparison between carbide and Wulff process acetylene. The comparison between acetylene and competing raw materials (as ethylene) is outside the scope of this paper.

## Acetylene from Light Hydrocarbons

The production of acetylene by the decomposition of light hydrocarbons may be accomplished, broadly, either through the application of heat from combustion or by passing the feed through an electric arc. A number of processes employing one or another of these means have been studied, each with certain elements in common. First, a "cracking device" (furnace or electrical reaction chamber) together with a collection of coolers or scrubbers, producing a dilute stream of acetylene; second, a group of compressors to boost the dilute stream to a pressure suitable for recovery and separation of the acetylene; and third, a recovery and purification section generally consisting of absorption and distillation equipment.

At present, the processes which have reached the stage of commercial practicality employ thermal decomposition of the feed. For these pyrolyses, the conditions for obtaining substantial yields of acetylene from light hydrocarbons are: Temperatures above 2200 F. (the exact temperature varies with feed composition), short contact time, and low partial pressure of acetylene at the reaction zone.

The Wulff process was invented in 1925. It was then the first recognition of the simple statement that substantial yields of acetylene can be obtained by subjecting vaporizable hydrocarbons to high temperatures at low partial pressures for short periods of time. The delay in developing the process to a commercial scale was

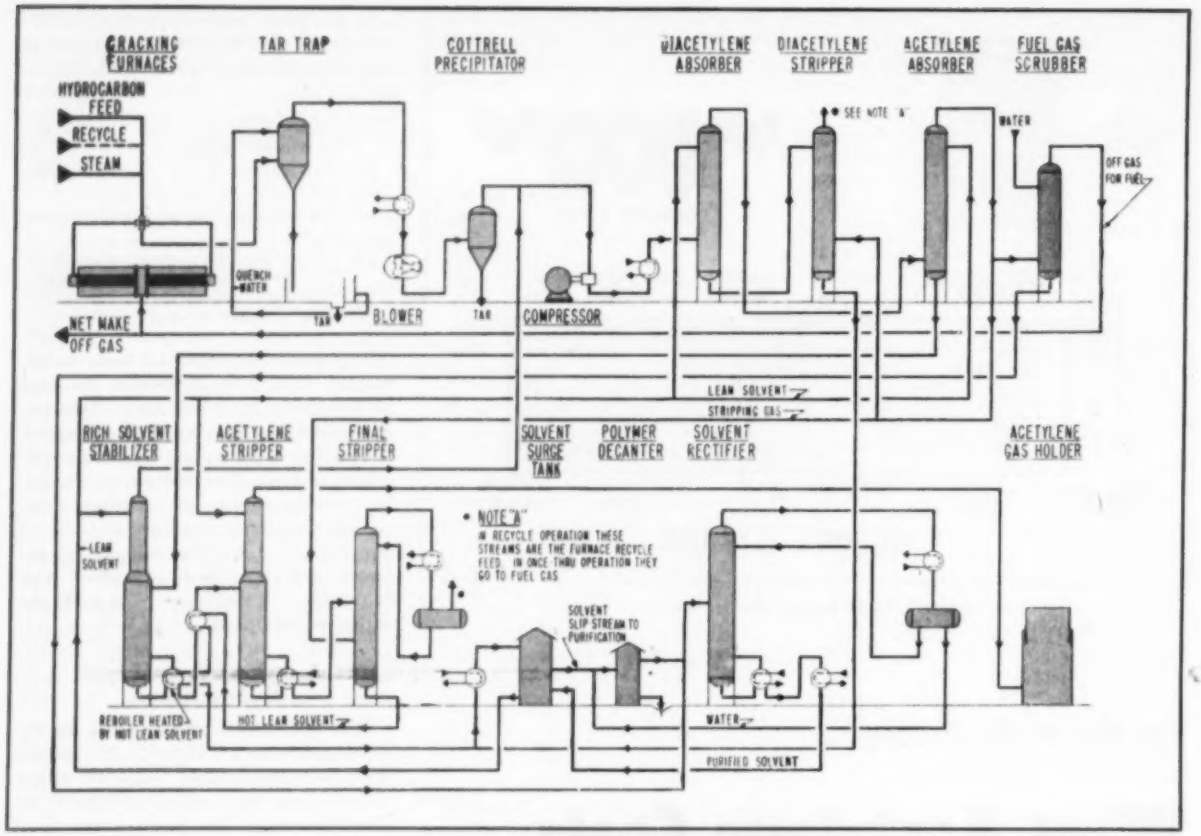



**Figure 2. Flow diagram for Wulff process**

caused by the need for demonstrating a practical technique of achieving high temperatures and short contact times in equipment that would operate reliably without unreasonable maintenance.

As the process is constituted today, its distinguishing feature is the use of a unique regenerative furnace to achieve pyrolysis of the feed. The low partial pressures are accomplished by a combination of the use of vacuum (the furnace operates at about 15 in. of Hg abs.) and steam dilution of the feed. The balance of a complete Wulff plant consists of the necessary coolers, scrubbers, blowers, compressors, absorbers, and fractionating equipment needed to separate and purify the acetylene.

To confirm the reliability of the new furnace design and to establish experience in the recovery and purification of the acetylene product, a small commercial demonstration plant has been in operation for nearly two years, and in almost continuous commercial production of acetylene for over a year. During the latter year the furnace operated without maintenance or repairs.

### Furnace

Figure 1 presents a horizontal sectional elevation and a vertical cross-section of the Wulff furnace, together with a detail of the moulded corundum checkers used. The detail brings out the manner in which the checkers, when stacked together, form a series of tubular gas passages, each surrounded by a heat absorbing mass of corundum. Section A-A shows the assembled furnace with the completed stack of checkers surrounded by a layer of high-temperature refractory firebrick, a layer of insulating firebrick and the steel shell of the furnace. The tubular passages through the checkers run in the horizontal direction, parallel to the horizontal centerline of the sectional elevation.

The sectional elevation shows: (a) The central soaking section of the furnace (established by omitting checkers), (b) a narrow void space to the right of center for the injection of fuel gas during alternate "heat" steps of the cycle. (The furnace is symmetrical about its vertical centerline. Thus, there is a second, similar void, not shown, at left of center, also used for fuel injection), (c) the entrance and exit plenum chambers at the left and right ends of the furnace, and (d) the auxiliary gas burner, extending into the top of the "soaking section," used for warming the furnace prior to start-up, or for holding temperature during short shut-down periods. Two of the fuel gas injection ports may be seen in this view of the right hand fuel injection void. The complete fuel gas injection headers and ports appear at each side of Section A-A.

Each complete operating cycle for this furnace includes four steps:

1. Heat with air flowing from right to left.
2. Crack with feed flowing from left to right.
3. Heat with air flowing from left to right.
4. Crack with feed flowing from right to left.

During Step 1, the first "heat" step, air enters the furnace from the plenum chamber on the right, flows through the hot refractory checkers, and is thus preheated to a temperature in the range of 1800-2000 F. by the time it reaches the right hand fuel injection void. Here it is mixed with fuel gas that is admitted through the injection ports. The fuel burns, raising the temperature of the air to its peak of 2200-2500 F. in the center "soaking section." As the flue gas (formerly air) flows on to the left it gives up its heat to the

refractory checkers, and is thus cooled to about 600 F. when it reaches the exit plenum chamber at the left.

In Step 2, the first "cracking" step, vaporized feed enters the furnace from the plenum chamber at the left and flows toward the right through the refractory checkers. Upon reaching the center void space, it has been heated to the peak cracking temperature (in the range of 2200-2500 F., depending upon the nature of the feed). Leaving the center void, the cracked vapors are then cooled by the checkers in the right hand half of the furnace. Exit temperature of the gas at the right hand plenum chamber is about 600 F. The total time that the gases are in the furnace is of the order of 0.1 second. A major portion of that time occurs in the center void or soaking section.

Step 3, the second "heat" step, follows the same pattern as Step 1, except that air enters from the left plenum chamber, flows to the right, and is mixed with fuel gas at the left hand fuel injection void.

Step 4, the second "cracking" step, follows the same pattern as Step 2, except that feed vapor enters from the right hand plenum chamber and flows toward the left.

In operation, each of these four steps lasts one minute, the complete cycle four minutes. This short cycle narrows the range of the temperature "swings" within the furnace, providing good control of cracking conditions and minimizing cyclic thermal stresses within the refractories. The variation in temperature of the refractory at a given point is only 25 to 30 F. throughout the course of a complete cycle.

The four steps, with their complete reversal of direction for both heating and cracking steps, serve to burn out any carbon deposits during the course of one cycle, and to insure that the peak temperature does not drift from the center of the furnace.

### Process

Figure 2 presents a flow diagram of a complete Wulff Process acetylene plant. Here is a brief process description:

Multiple furnaces in parallel are used to provide continuous flow of "cracked gas." Each furnace alternates between a "heating" and a "cracking" step. At any given time a mixture of feed vapor and dilution steam flows to one-half of the total number of furnaces, while air and fuel gas for heating flow to the other furnaces. Each furnace is reversed approximately every 60 seconds.

Flue gas effluent from the heating step flows from the furnaces to a blower and is exhausted to the atmosphere. Cracked gas effluent from the furnaces is cooled by direct contact with water to condense and scrub out tars (no carbon black is produced); it is then compressed to atmospheric pressure by the cracked gas blower, flows through a Cottrell precipitator for final cleanup, and is compressed to recovery-system pressure in the main compressors.

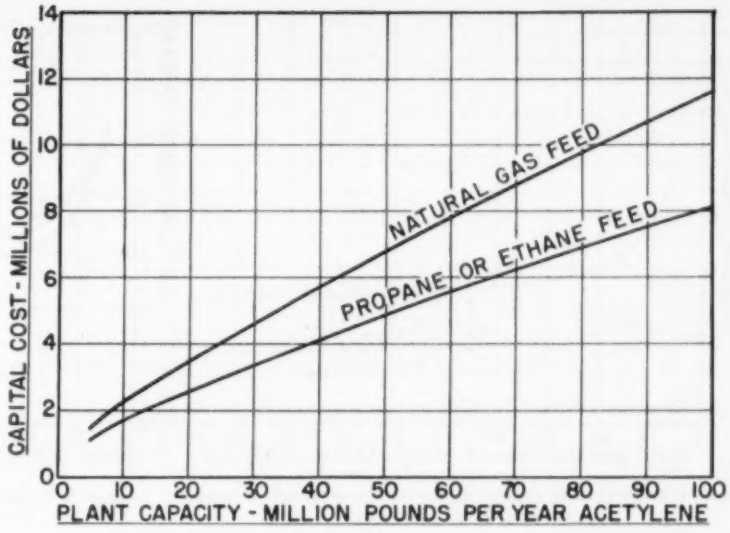



**Figure 3. How capital cost rises with plant capacity for Wulff process acetylene plants**

The recovery and purification section described, like that of the demonstration plant, uses a high-boiling solvent (350-400 F.) for absorption and separation of the acetylene. Several suitable solvents of similar general properties are available for this service. In the demonstration plant, acetonyl acetone has been used.

The compressed gas flows to the diacetylene absorber where it is contacted with a small stream of lean solvent to remove the bulk of the diacetylene contaminant and some of the other higher homologs of acetylene. Solvent from the bottom of the diacetylene absorber flows to the diacetylene stripper where these contaminants are stripped out with a small stream of residue gas, which then in turn goes to the furnace as fuel. The stripped solvent returns to the lean solvent surge tank.

The main gas stream flows from the diacetylene absorber to the acetylene absorber where it is contacted with a major portion of the lean solvent. Residue gas from this absorber is divided. Small portions of it are used for stripping in the diacetylene stripper and final stripper and then go to the furnaces for fuel. The major portion is scrubbed with water to recover vaporized solvent, and then flows to the main fuel-gas system where it is used as fuel for the furnaces, gas engines, or boilers.

Rich solvent from the acetylene absorber flows to the rich solvent stabilizer. In this column, which is reboiled and refluxed with a small stream of lean solvent, ethylene, carbon dioxide, methane, hydrogen and other constituents more volatile than acetylene are taken overhead. These are then recycled through the main compressors to the acetylene absorber where they are eventually rejected.

Rich solvent flows from the bottom of the rich solvent stabilizer to the acetylene stripper. In this column, which is reboiled and refluxed with a small stream of lean solvent, the acetylene product is taken overhead to storage, while methylacetylene and other less volatile constituents, including the balance of higher homologs of acetylene, are retained in the bottoms. This solvent stream then flows to the final stripper where these higher homologs of acetylene are removed by stripping with residue gas.

In the course of heating solutions of acetylene and its homologs, a small fraction polymerizes to a tarry material. To remove this polymer from the solvent, a small slip-stream of the lean solvent is withdrawn from the solvent surge tank, diluted with water, and then sent to the polymer decanter where the polymer, now present as a separate phase, settles out, and is withdrawn. The aqueous solution then joins the bottoms from the fuel gas scrubber and flows to the solvent rectifier, where water is removed by distillation. The

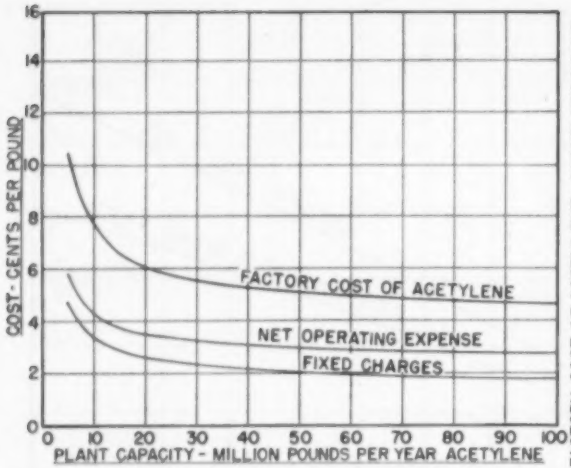

COST - CENTS PER POUND
FACTORY COST OF ACETYLENE
NET OPERATING EXPENSE
FIXED CHARGES
PLANT CAPACITY - MILLION POUNDS PER YEAR ACETYLENE

Figure 4. Effect of plant capacity on factory cost of acetylene (natural gas feed in Gulf Coast area)

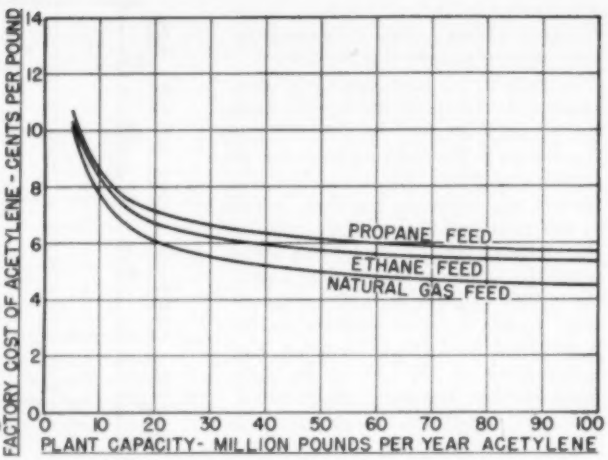

FACTORY COST OF ACETYLENE - CENTS PER POUND
PROPANE FEED
ETHANE FEED
NATURAL GAS FEED
PLANT CAPACITY - MILLION POUNDS PER YEAR ACETYLENE

Figure 5. Comparison of factory costs of acetylene via Wulff process from three feed stocks (Gulf Coast location)

purified solvent is then returned to the system.

In certain applications where feed has an unusually high value, the raw-feed requirements and the net production of residue gas to fuel may be minimized by recycling a portion of the residue gas along with the fresh feed to the furnace. This achieves a higher yield of acetylene for each unit of feed, at the expense of larger equipment for the plant. For such a "recycle" operation, the recycle stream is made up of the gas from the diacetylene stripper and the final stripper.

### Basis of Data

Yields and compositions used here are based on data obtained in the small commercial demonstration plant. However, a word of comment. While the demonstration plant has been operated continuously to provide data for plant design on propane and on natural gas, only a few runs have been made on ethane. These do not constitute a firm basis for final plant design, but, owing to the interest in ethane as charge stock, a conservative interpretation has been included to provide an approximate picture.

In the studies presented here, the acetylene plant is treated as one process unit in a large chemical plant. Thus, capital costs are given for a "battery limits" plant, with steam and cooling water supplied from a central plant. In computing operating expenses, the values assigned to steam and circulated cooling water are intended to be consistent with the cost of fuel for the area considered, and high enough to include fixed charges and operating costs for the central utility facilities. By similar reasoning, labor charges for administrative personnel and such service groups as accountants, chemists, and watchmen are on a part-time basis.

For the natural gas feed stock, a typical natural gas having a gross heating value of 100 Btu per standard cubic foot has been assumed. The ethane feed stock has been taken as containing 90 percent ethane. In the case of propane, a typical commercial grade material having a purity of approximately 90 percent has been assumed.

Each of the operations considered is on a "once-through" basis; there is no recycle of residue gas with the furnace feed.

It has been assumed that the boiler plant and other furnace fuel requirements for the entire chemical plant will be large enough to consume all the residue gas from the acetylene plant. In most instances there will be no question on this point. Accordingly, residue gas is credited to the process on a Btu basis, equivalent to fuel.

Capital and operating costs, and utility requirements are based on using gas-engine drives for the main compressors. Where conditions favor steam-driven centrifugal compressors, this substitution may be made with attendant savings in capital and utility costs.

In connection with operating expenses and fixed charges against capital investment, sufficient background information is shown in a sample tabulation to permit adjustment of the final figures for the variations in unit costs and percentages normally encountered among different organizations.

As expected, the purity of the acetylene affects the capital and operating costs of the recovery and purification equipment. In the cases presented, the expected product is 99 volume percent acetylene. The principal impurities are 0.3 volume percent methylacetylene, 0.5 volume percent carbon dioxide, and 0.2 volume percent ethylene.

Capital costs shown cover the complete "battery limits" including:

All buildings in process area, such as operating control room, compressor house and electrical switch house.

Acetylene product gas holder to store full product for one hour.

Propane storage tanks: For the case of propane feed, capacity is provided for five and one-half days' normal feed requirements. For natural gas or ethane feed, capacity is provided for approximately three days' emergency operation on propane.

Initial charge of solvent.

Operating spare pumps and drives. Spare parts and materials for warehouse stock are not included.

Cost of engineering and design.

Contractors' fees.

### Cost of Wulff Process Acetylene

Table 1 shows material balances and utility requirements for three Wulff acetylene plants, located in the Gulf Coast area, each to produce 20 million pounds of acetylene a year.

Table 2 shows, for each of the three plants, capital costs, fixed charges, operating expenses, and total "factory cost" of the product acetylene. The prices shown for natural gas and propane are current estimates of the long-term market values of these products. The price shown for ethane is estimated to include its value on a heat basis, plus the cost of separating it from a typical natural-gasoline plant residue gas stream.

An annual average stream-day efficiency of 90 percent has been used in computing the material balances and costs. However, no specific allowance has been made for "load factor," the ratio of actual average operating rate to the nominal or design calendar-day

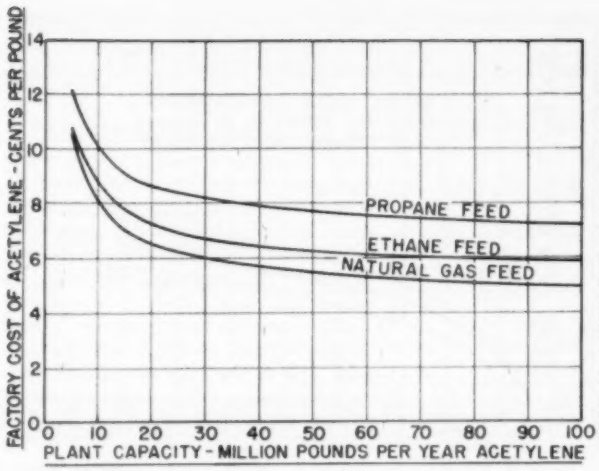



Figure 6. Comparison of factory costs of acetylene via Wulff process from three feed stocks (Ohio Valley location)

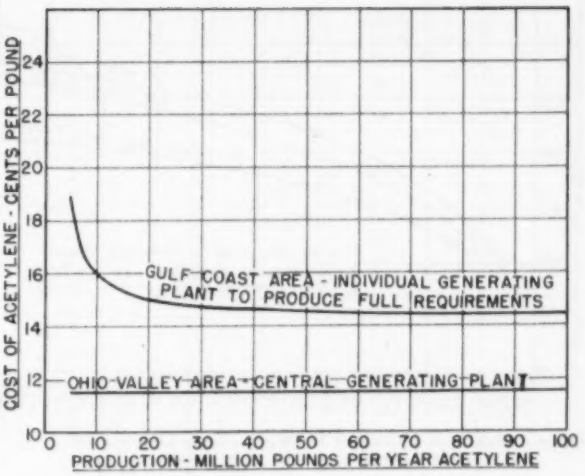



Figure 7. Cost of carbide acetylene at two different locations

capacity. Load factor is controlled by ability to sell or inventory the final product, and by the amount of extra capacity built into the plant to allow for future market growth. Accordingly, it will vary with the nature of the end product to be made from the acetylene. To correct the figures presented for load factor, the fixed charges against capital, labor costs, costs of supplies and of solvent (all expressed in cents per pound of acetylene product) must be increased by dividing them by the ratio just described to define load factor.

Figure 3 shows for natural gas, ethane and propane feed, the effect of plant size (as measured by acetylene production rate) on capital investment.

Figure 4 shows for natural gas feed, the effect of plant size on fixed charges against capital, operating expenses and "factory cost" of acetylene, for plants located in the Gulf Coast area.

Figure 5 shows the effect that changing the feed to ethane or propane would have on the factory cost of acetylene as a function of plant size, in the same locality.

For operations located outside the Gulf Coast area, the cost of hydrocarbon feed for a Wulff plant will be higher than the values used in Table 2 and Figures 4 and 5. Correspondingly, the costs of steam and the value of the residue gas as fuel are also higher. To indicate the magnitude of these effects, and to provide background for a comparison to be made at a later point in this paper, data are presented for the area of the lower Ohio River Valley. Table 3 shows for each of the three feed stocks, the factory cost of Wulff Process acetylene in the lower Ohio River Valley. As before, prices taken for natural gas and propane are based on current estimates of their long-term market values; the price for ethane includes its value on a heat basis for this locality, plus the cost of separating it. (For this case separation is assumed to be performed in a stripping plant located on one of the major natural-gas transmission pipe lines.)

Figure 6 shows for natural gas,

**TABLE 1**

**Material Balances and Utility Requirements**

**For 20-Million-Pound-Per-Year Wulff Process Acetylene Plants**

| Material Balances | FEED MATERIAL | | |
|---|---|---|---|
| | Natural Gas | Ethane | Propane |
| **Feed:** | | | |
| M Std. cu. ft./day | 7,850 | 1,860 | |
| Gal./day | | | 46,800 |
| **Yields:** | | | |
| Percent Feed converted to acetylene* | 21.8 | 48.6 | 38.4 |
| Lbs. acetylene recoverable/100 lb. feed | 16.2 | 37.9 | 30.7 |
| **Off Gas:** | | | |
| Net excess std. cu. ft./hr.† | 458,400 | 163,800 | 190,000 |
| Heating value (HHV) Btu/cu. ft. | 605 | 457 | 523 |
| Excess M Btu/hr. | 276,000 | 74,800 | 99,400 |
| **UTILITY REQUIREMENTS** | | | |
| Steam (300 psig) lbs./hr. | 83,176 | 78,976 | 68,976 |
| Cooling Water gal./min. | 10,364 | 7,974 | 7,350 |
| Electricity, kw | 950 | 853 | 889 |

* Conversion is percent of carbon in feed which appears as carbon in furnace effluent acetylene.

† Excess taken after deduction of fuel for reaction furnaces and gas engine drives for main compressors.

All quantities are on a "stream day" basis. To obtain calendar day rates multiply by 0.9.

**TABLE 2**

**Cost of Acetylene Produced via Wulff Process in Gulf Coast Area**

**In Plants Producing 20 Million Pounds Per Year Acetylene**

| | FEED MATERIAL | | |
|---|---|---|---|
| | Natural Gas | Ethane | Propane |
| Capital Investment | $3,456,000 | $2,561,000 | $2,572,000 |
| | Cents/Lb. Acetylene Exclusive of Royalty | | |
| Fixed charges on investment* | 2.68 | 1.98 | 1.99 |
| **Operating Expenses:** | | | |
| Steam (300 psig) at 30 cents/M lbs. | .99 | .93 | .82 |
| Cooling water at 1.5 cents/M gal. | .37 | .28 | .26 |
| Electricity at 1 cent/kw. hour | .37 | .34 | .35 |
| Natural gas at 15 cents/MM Btu. | .213 | | |
| Ethane at 1 cent/lb. | | 2.42 | |
| Propane at 4 cents/gal. | | | 3.06 |
| Solvent at 40 cents/lb. | .39 | .39 | .39 |
| Labor† | .61 | .61 | .61 |
| Supplies | .10 | .10 | .10 |
| Fuel gas credit at 15 cents/MM Btu. | —1.65 | —.49 | —.63 |
| Total Factory Cost | 5.99 | 6.56 | 6.59 |

* Fixed charges at 15.5 percent a year to include depreciation, taxes, insurance, interest and maintenance.

† Labor costs include direct operating labor costs plus part-time services of chemist, accountant, watchman, superintendent and administrative personnel, plus 22 percent for vacations, insurance and benefits.

**TABLE 3**

**Cost of Acetylene Produced via Wulff Process in Ohio Valley Area**

**In Plants Producing 20 Million Pounds Per Year Acetylene**

| | FEED MATERIAL | | |
|---|---|---|---|
| | Natural Gas | Ethane | Propane |
| Capital Investment | $3,456,000 | $2,561,000 | $2,572,000 |
| | Cents/Lb. Acetylene Exclusive of Royalty | | |
| Fixed charges on Investment* | 2.50 | 1.98 | 1.99 |
| **Operating Expense:** | | | |
| Steam (300 psig) at 37 cents/M lb. | 1.21 | 1.15 | 1.01 |
| Cooling water at 1.5 cents/M gal. | .37 | .28 | .26 |
| Electricity at 1 cent/kw. hour | .37 | .34 | .35 |
| Natural gas at 20 cents/MM Btu. | 2.84 | | |
| Ethane at 1.2 cents/lb | | 2.90 | |
| Propane at 6 cents/gal. | | | 4.59 |
| Solvent at 40 cents/lb. | .39 | .39 | .39 |
| Labor† | .61 | .61 | .61 |
| Supplies | .10 | .10 | .10 |
| Fuel gas credit at 20 cents/MM Btu. | 2.20 | —.65 | —.84 |
| Total Factory Cost | 6.37 | 7.10 | 8.46 |

* Fixed charges at 15.5 percent a year to include depreciation, taxes, insurance, interest and maintenance.

† Labor costs include direct operating labor costs plus part-time services of chemist, accountant, watchman, superintendent and administrative personnel, plus 22 percent for vacations, insurance and benefits.

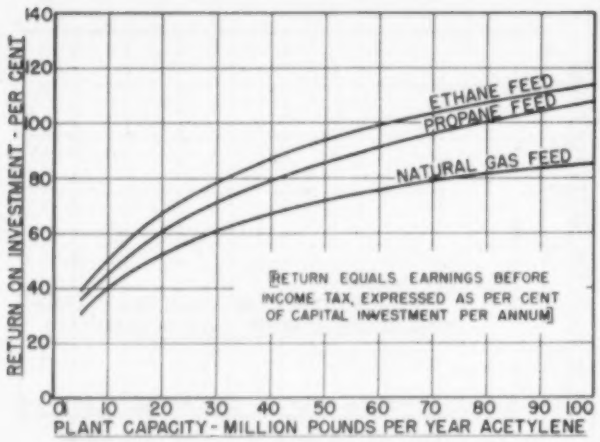



Figure 8. Return on investment for Wulff process acetylene based on cost of carbide acetylene (Gulf Coast area)

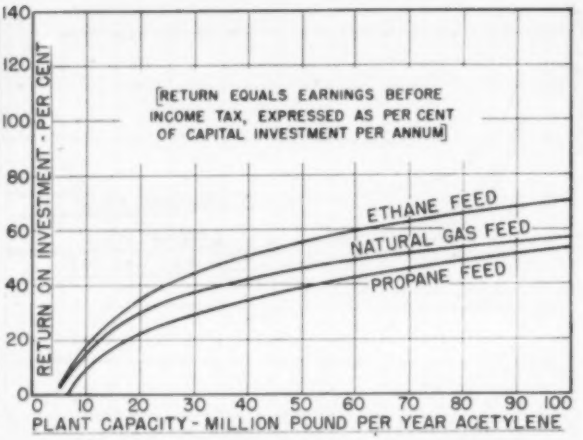



Figure 9. Return on investment for Wulff process acetylene plants based on cost of carbide acetylene (Ohio Valley area)

ethane and propane, respectively, the effect of plant size on cost of acetylene in the lower Ohio River Valley.

### Wulff vs. Carbide

It is of interest to compare Wulff process acetylene with acetylene prepared from calcium carbide.

The generation of acetylene from carbide is accomplished by reacting the carbide with water. The generator effluent is scrubbed to remove hydrogen sulfide and phosphine, and is then delivered at a purity of about 99½ percent. The equipment required for generation and scrubbing is of quite standard design and involves a nominal capital investment. The major cost is that of the carbide itself, with transportation of the carbide a potentially significant factor.

Calcium carbide is manufactured on a large scale only in those localities which combine low cost electric power with supplies of high quality limestone and coke. Thus, when carbide acetylene is to be used at a point removed from these localities, it is necessary to ship the carbide, rather than manufacture it at the point of use. For substantial operations, calcium carbide is shipped to the user in steel hoppers of 5-ton capacity, designed to be handled on a flat car and to couple directly to the acetylene generator. In such a case the freight charges for moving the full and empty hoppers, and the "fixed charges" against the capital investments in hoppers may become a large factor in the total cost of the carbide acetylene.

In recent years there has been a trend toward "on-the-spot" acetylene generation, eliminating costs of freight and rehandling of the carbide. In these cases, large chemical synthesis operations are located adjacent to a carbide manufacturing plant where the carbide manufacturer sets up and operates the generators and sells purified acetylene "across the fence."

Whether the carbide-acetylene user chooses to locate close to an "on-the-spot" generating plant, or to purchase the carbide, ship it to his own location and generate the acetylene himself, he obtains the acetylene with a relatively low capital investment. On the other hand, as shown, production of acetylene by the Wulff process involves a substantial capital investment. Accordingly, the Wulff process will only be chosen over the carbide route when it can provide a large enough saving to pay a suitable return on this investment.

The Gulf Coast area is far removed from the sources of calcium carbide. Consequently, carbide acetylene is expensive there, and, in fact, has not been widely used for chemical synthesis. A chemical user in this area would purchase carbide and operate his own generators. On the other hand, the lower Ohio River Valley contains some major sources of carbide. A chemical user operating adjacent to "on-the-spot" generating facilities in this area would enjoy carbide acetylene at a most favorable price. These two cases, individual generation in the Gulf Coast area, and "on-the-spot" purchase in the lower Ohio River Valley, are chosen for comparison with the Wulff process.

In Figure 7, the upper curve shows the total cost of carbide acetylene as a function of annual rate of consumption for individual generating facilities located in the Gulf Coast area. The cost indicated by this curve includes a suitable return on investment in generating facilities.

In Figure 7, the lower curve, a horizontal straight line, shows the price at which it is reported carbide acetylene may be purchased "across-the-fence" from an "on-the-spot" generating plant in the lower Ohio River Valley, on the basis of a long term contract, and high load factor.

Figure 8 shows, for the Gulf Coast area, the difference between the cost of carbide acetylene and the "factory cost" of Wulff process acetylene, for three feeds, expressed as percent return, before income tax, on capital invested in the Wulff process plant. The significance of the low end of these curves is straight-forward. However, since operations using carbide acetylene on the scale indicated by the upper portion of the curves have probably not been seriously considered for the Gulf Coast area, the curves here merely serve to emphasize the point that for this geographic locality the economics of acetylene have been materially changed.

Figure 9 shows, for the lower Ohio River Valley, the difference between the price of carbide acetylene and the "factory cost" of Wulff process acetylene for three feeds, expressed as percent return, before income tax, on capital invested in the Wulff process plant. These curves show that for small operations in this area, the economic choice, other things being equal, is to locate the chemical plant adjacent to "on-the-spot" carbide acetylene generating facilities. However, for larger operations, the Wulff process offers an attractive investment.

#### ACKNOWLEDGMENTS

The author wishes to acknowledge the valuable assistance given by members of the engineering department of The Fluor Corporation, Ltd., and to thank The Wulff Process Company and The Fluor Corporation, Ltd., for permission to publish.

Portions of this paper are reprinted from *Chemical Engineering Progress*, 49, 35-39 (January, 1953).

Excerpts from this paper were presented at the Oklahoma State meeting of AIChE, Tulsa, September, 1952, at the Seventh Annual Technical Meeting of the South Texas Section of the AIChE, Houston, October, 1952, and at the 45th National Meeting of the AIChE in Cleveland, Ohio, December, 1952.

**Aksel C. Eld**
Gulf Oil Corporation
Pittsburgh

# A New Approach to TRAY DESIGN

**Featured are a new equation for tray design plus important operating and design data for perforated trays**

THE PRIMARY purpose of this paper is not to discuss design of trays in detail but to present data and observations from the author's experience to show why he is of the opinion that the suspension Equation (4) and other equations derived from or combined with it, are not based upon the fundamental factors governing tray operation, and are, therefore, not the proper equations to use in tower design. The jetting Equation (15) is proposed as a design equation which more nearly accounts for the factors affecting proper tray operation.

Up to the present time, engineers in the oil refining industry have used Equation (4) almost exclusively for determining permissible vapor velocity in fractionating towers. The development of Equation (4) is as follows:[1]

$$F_s = K \times \mu \times \frac{V\pi}{2} \times D_p \times V_o + k \times D_v \times \frac{\pi \times D_p^2}{4} \times V_o^2 \quad (1)$$

$$F_s = k \times D_v \times \frac{\pi \times D_p^2}{4} \times V_o^2 \quad (2)$$

$$F_s = \frac{\pi \times D_p^3}{6} (D_L - D_v) \times g \quad (3)$$

$$V_o = C_o \sqrt{\frac{D_L - D_v}{D_v}} \quad (4)$$

$$U_v = C_o \times \sqrt{\frac{D_L - D_v}{D_v}} \quad (5)$$

$$C_o = \frac{2 \times g \times D_p}{3 \times k} \quad (6)$$

Equation (1) is an expression for the resistance of a sphere in a moving fluid.

It may be written as Equation (2) since the viscosity of vapor is low (.01 to .001 centipoises).

Equation (3) shows the force of gravity (less bouyancy) on a spherical particle.

From Equations (2) and (3), Equation (4) is obtained, which expresses the upward velocity of a fluid (vapor) required to suspend a body (liquid drop). Maximum permissible vapor velocity is assumed to be reached when liquid droplets are not carried in excess to the tray above.

Assumptions and constants are all included in the factor "$C_o$."

It is assumed that the size of the liquid droplets are all equal. "K" and "k" are empirical factors. "$C_o$" also includes the effect of other known or unknown variables, such as surface tension of the liquid which is fed to the tray, and, to a large extent, the design of the bubble tray which influences the amount and force of jetting.

It has been recognized from the very beginning that "$C_o$" varies considerably with the tray spacing, although the development of Equation (4) does not take this into consideration. Few designers have ever completely agreed on the values of "$C_o$" for various tray spacings.

It has also become evident to leading tray designers, as well as to the author of this paper, that the value of "$C_o$" as determined for an atmospheric tower should not be used in Equation (4) to design a vacuum tower. It has been found that the resulting vapor velocities for similar tray designs are too high for vacuum towers. It has also been found that in some cases a high pressure tower may be designed for higher vapor velocities than would be predicted by equation (4) using values of "$C_o$" which correspond to proper design for atmospheric tower, and when similar tray design is employed.

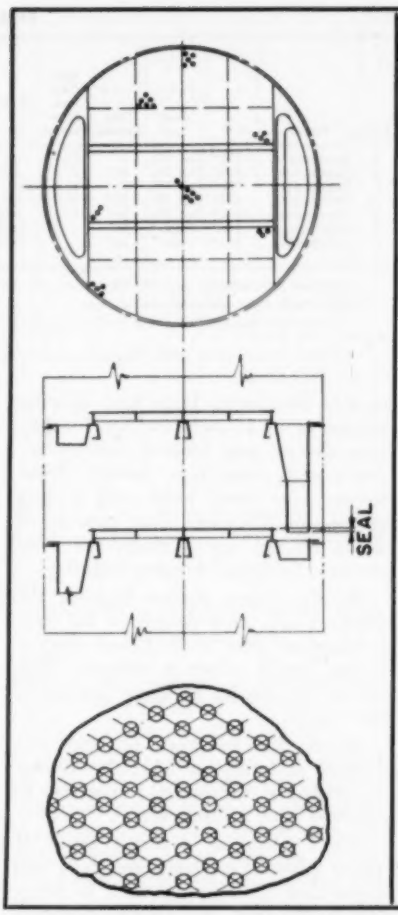



Figure 1. Typical layout of perforated plate type tray.

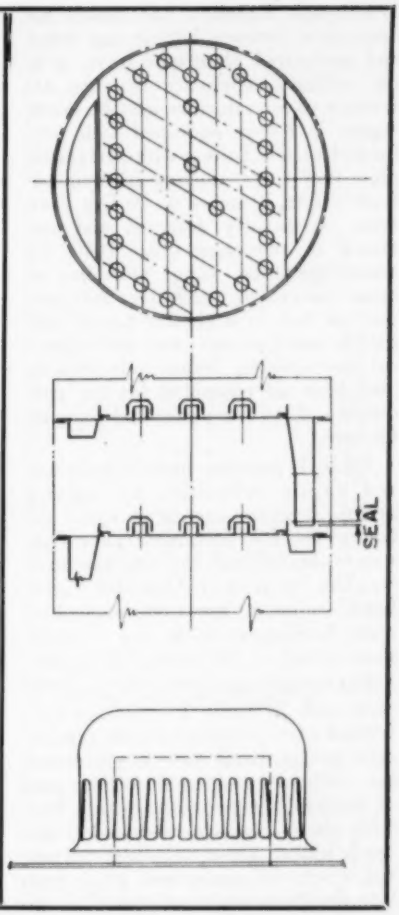



Figure 2. Typical layout of bubble cap type tray.

Although Equation (4) makes no distinction between bubble cap trays and perforated plate type trays, it is the author's experience that the allowable vapor velocities may be much higher in towers equipped with perforated plates. Towers with perforated plate type trays, ranging in diameter from 2 feet, 8 inches to 10 feet have been successfully designed and operated in refineries since 1940. In actual operation, vapor velocities in these towers may reach over 200 percent of that in a similar tower with bubble cap type trays and with identical tray spacing. Vapor velocities as used here are computed for the area directly above the perforated plate or the caps.

Table 1 presents main dimensions and vapor velocities for various towers. It shows operating vapor velocities for five perforated plate type tray towers and two cap type tray towers. The "percent of Allowable Vapor Load" refers to the vapor capacities given in Figures 4, 5, and 6 which show a load of 100 percent allowable.

The corresponding load is given, in each case, in Table 1, when the perforated plate is replaced with caps or caps are replaced with a perforated tray without changing the vapor area of the tray in size or square feet. This table shows concrete examples of the much higher vapor velocities permitted when the perforated plate type tray design is employed instead of the cap type tray design. For instance, Item B shows that if this tower had been equipped with cap type trays, the vapor velocity or vapor load would have to be decreased to 53 percent of present load in order not to exceed the maximum allowable load, as given in Figure 3, or the vapor load should be decreased to 46.5 percent of present load to correspond to the present load of 87.2. Similarly, item F shows that the vapor load may be increased to 238 percent when the caps are replaced with a perforated plate of 36.6 percent free area. This tabulation illustrates—as outlined above—that the vapor velocity in the area between the trays is not an important factor in liquid entrainment or limitation of vapor load as assumed in the development of Equation (4).

The failure of Equation (4) to account for these factors, as outlined above, leads one to suspect that it is not based on the proper fundamental factors which govern the maximum allowable velocity in towers.

It should be noted that the above, as well as the following, refers to fractionating towers with relatively large tray spacing, as primarily used in the oil refining industry. In regard to this discussion, large tray spacing ranges from 18-inch and up for cap type design, and 16-inch and up for perforated plate type design. Some towers have been built with a tray spacing of 42 inches. Tray spacing of 24 to 30-inch are perhaps the most common in the oil refining industry.

**TABLE 1**

| Item | Service | I.D. | Tray Type | Tray Spacing | Perf. Plate Free Area Percent | $D_L$-$D_V$ / $D_V$ | **VAPOR AREA Sq. Ft. | **VAPOR AREA †Vapor Vel. Ft./S | PERCENT OF ALLOW VAPOR LOAD Actual | PERCENT OF ALLOW VAPOR LOAD *Cap | PERCENT OF ALLOW VAPOR LOAD *Perf. Plt. | Equation Applied | Operation Started |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Debutanizer | 5'-0" | Perf. Plt | 24" | 36.6* | 29.1 | 8.21 | 2.87 | 90.0 | 204 | ..... | (5) | 1943 |
| B | Demetanizer | 3'-0" | Perf. Plt. | 30" | 36.6 | 4.28 | 3.30 | 1.58 | 87.2 | 188 | ..... | (5) | ..... |
| C | Deheptanizer | 2'-8" | Perf. Plt. | 24" | 32.6 | 102 | 3.20 | 4.37 | 86.5 | 167 | ..... | (5) | 1952 |
| D | Debutanizer | 6'-0" | Perf. Plt. | 24" | 22.6 | 16.3 | 12.00 | 1.21 | 85.0 | 117 | ..... | (5) | 1944 |
| E | Depropanizer | 10'-0" | Perf. Plt. | 30" | 22.6 | 4.59 | 40.00 | .88 | 84.9 | 116 | ..... | (5) | 1948 |
| F | Deisobutanizer | 8'-0" | Caps | 24" | ..... | 22.55 | 30.5 | 1.17 | 96.0 | ..... | 42 | (5) | 1945 |
| G | Debutanizer | 5'-0" | Caps | 24" | ..... | 25.05 | 9.0 | 1.05 | 89.0 | ..... | 35.2 | (5) | 1948 |

* Computed for comparison only, 36.6 percent free area of perforated plate.

** Area directly above perforated plate or caps.

† Actual vapor velocity (Vapor Load in CF/S/Sq. Ft.) is not necessarily equal to the maximum allowable vapor velocity as given on Fig. 4, 5, 6.

Efficiency data are not available—Operation and performance are acceptable.

Of all the unknown or empirical factors included in (4), the jetting is probably the most important to consider and investigate.

Since jetting is a direct cause of vapor blowing through the caps and contacting the liquid which is being fed to the tray, a "jetting" equation may be developed as follows:[2]

The left hand part of Equation (7) expresses the kinetic energy lost by the vapor $W_v$ as it changes in velocity from V to $V_T$. The right hand part of the Equation (7) expresses the height H to which the liquid $U_L$ is pushed when it receives the kinetic energy given up by the vapor.

$$\frac{W_v}{2_{ge}} \times (V^2 - V_T^2) = H \times U_L \times (D_L - D_V) \frac{g}{g_c} \quad (7)$$

$$B = \frac{a}{A} \quad (8)$$

$$W_v = D_V \times V \quad (9)$$

$$V_T = B \times V \quad (10)$$

$$\frac{1}{2g} \times D_V V^2 (1 - B^2) = H \times U_L \times (D_L - D_V) \quad (11)$$

$$V = \sqrt[2]{2g} \times \sqrt[3]{H} \times \sqrt[3]{U_L} \times \sqrt[3]{\frac{D_L - D_V}{D_V}} \times \sqrt[3]{\frac{1}{1 - B^2}} \quad (12)$$

$$V = C \times \sqrt[3]{\frac{D_L - D_V}{D_V}} \quad (13)$$

$$V = \frac{U_V}{a} \quad (14)$$

"A" in (8) may be equivalent to one square foot or one cap, or any number of caps or any other basis the designer may choose for his particular tray design or layouts. From Equations (13) and (14), and considering one square foot of vapor area directly above the caps or perforated plate, we have

$$U_V = C_t \times \sqrt[3]{\frac{D_L - D_V}{D_V}} \quad (15)$$

where $C_t = c \times a$ (16)

Equation (15) expresses the permissible volume of vapor for one square foot of the vapor area.

Equation (12) indicates that for a given vapor velocity, all the liquid of volume $U_L$ would be pushed to a height of H feet, providing a perfect transfer of energy from vapor to liquid is obtained. In actual operation, it is not desirable to push the liquid to a height of H feet (H = tray spacing). Due to some unevenness in distribution of liquid and vapor to the tray, liquid gradient, and the design of the tray, the height to which the liquid is pushed varies across the tray.

Equation (12) indicates that the vapor velocity may be increased when the volume of the liquid to the tray is increased. However, a large liquid volume frequently results in uneven liquid distribution, due to liquid gradient and difficulty in designing proper inlet and outlet weirs, which in turn causes uneven vapor distribution and velocities. Equation (12) does not then apply. In fact, the average allowable vapor velocity may become lower instead of higher.

This is particularly the case for tray designs that permit excessive jetting in spots, which may be due to faulty design of the tray or high liquid gradient. It has been the author's experience that for a very small volume of liquid, excessive entrainment takes place at relatively high vapor velocities that otherwise should be expected to permit proper operation. Equation (12) substantiates this phenomenon in that when decreasing liquid volume, the allowable vapor velocity becomes lower. The extent of the correction for

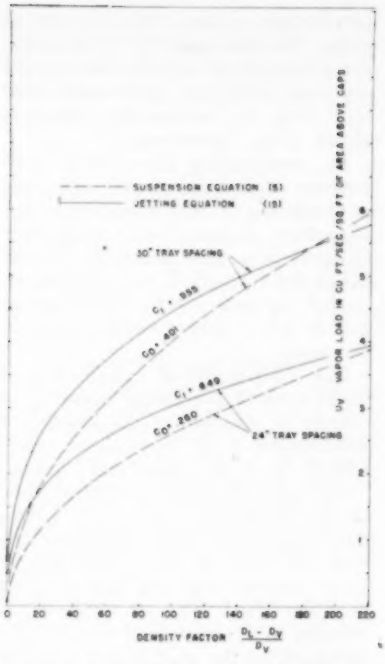

SUSPENSION EQUATION (5)
JETTING EQUATION (13)
30" TRAY SPACING
$C_1$ = 995
$C_0$ = 401
$C_1$ = 649
$C_0$ = 260
24" TRAY SPACING
$U_V$ VAPOR LOAD IN CU FT/SEC/SQ FT OF AREA ABOVE CAPS
DENSITY FACTOR $\frac{D_L - D_V}{D_V}$

Figure 3. Vapor capacity for cap type trays.

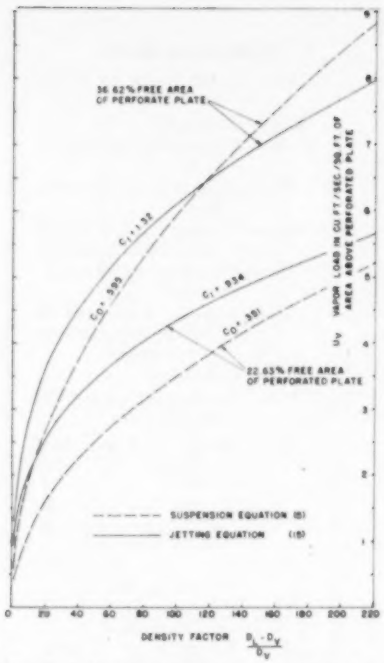

36.62% FREE AREA OF PERFORATE PLATE
$C_1$ = 1132
$C_0$ = 595
$C_1$ = 934
$C_0$ = 351
22.63% FREE AREA OF PERFORATED PLATE
SUSPENSION EQUATION (5)
JETTING EQUATION (13)
$U_V$ VAPOR LOAD IN CU FT/SEC/SQ FT OF AREA ABOVE PERFORATED PLATE
DENSITY FACTOR $\frac{D_L - D_V}{D_V}$

Figure 4. Vapor capacity for perforated plate type trays, 24-inch spacing.

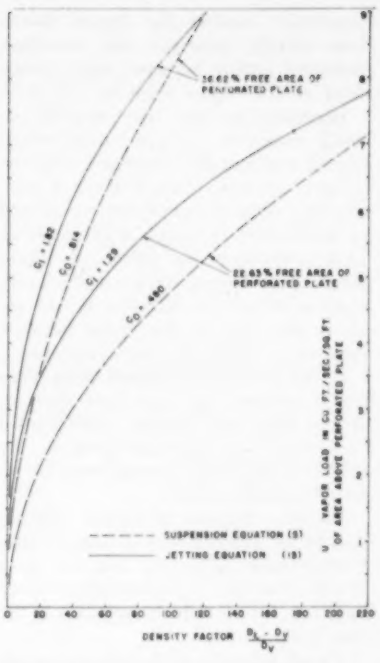

36.62% FREE AREA OF PERFORATED PLATE
$C_1$ = 1180
$C_0$ = 814
$C_1$ = 1139
$C_0$ = 480
22.63% FREE AREA OF PERFORATED PLATE
SUSPENSION EQUATION (5)
JETTING EQUATION (13)
$U_V$ VAPOR LOAD IN CU FT/SEC/SQ FT OF AREA ABOVE PERFORATED PLATE
DENSITY FACTOR $\frac{D_L - D_V}{D_V}$

Figure 5. Vapor capacity for perforated plate type trays, 30-inch spacing.

permissible vapor load as a function of liquid load is largely dependent on tray design. A small volume of liquid should be restricted to as small an area as possible. With a large volume of liquid, the tray must be designed for even distribution. In this latter case, multipass trays may be used to decrease the liquid gradient and uneven liquid distribution.

Finally, Equation (12) includes a design factor B, which represents the ratio of the restricted area, "a," on the tray, which usually is the slot area or the disengaging area (area between the caps) and the area directly above the caps "A."

Equation (12) indicates that the allowable vapor velocity increases as the value of "B" increases. This means that the allowable vapor velocity approaches infinity when the numerical value of the slot or disengaging area (whichever is the restricted or controlling area) approaches that of the area directly above the caps.

However, Equation (12) holds only when all the liquid is contacted by all the vapor, and it would be difficult, or even impossible, to design a bubble cap type tray with very large slot and disengaging areas and obtain adequate vapor and liquid contact and distribution.

At the present time, a considerable number of fractionating towers in operation have perforated plate type trays with a large free area (perforated holes) of up to 36.6 percent of plate area (see Table 1). The free area corresponds to the slot area or the disengaging area on cap type trays. The relatively large free area, combined with an almost ideal vapor and liquid distribution permits high vapor loads. This tends to confirm the soundness of Equation (12) in that it implies that the controlling velocity is the velocity in the restricted area which causes jetting, rather than the vapor velocity in the space between the trays. Uniform liquid distribution prevents localized jetting of liquid to the tray above.

The perforated plate type trays, including those which are listed in Table 1, are designed without weirs as indicated in Figure 1, and it is not intended to maintain any definite liquid level on the tray. The vapor velocity through the closely spaced holes of maximum 7/64-inch diameter is sufficient to prevent the liquid leaking through the tray.

As the liquid is fed to the tray from the sump below the downflow of the tray above, it is immediately picked up by the vapor rising through the holes in the perforated tray. It is held in suspension in the form of droplets above the tray as it flows from the inlet to the outlet side of the tray. As the droplets reach the outlet of the vapor-liquid contact area and flow into the area above the downflow section, they drop out of suspension, since the high vapor velocity and jetting action of the vapor is not present.

The operation of a cap type tray may be readily compared to that of a perforated tray when considering relatively high tray spacing (18-inch and up) and with reference to Equation (12). The major function of the slots in the caps is to distribute the vapor that is charged to the tray so that an efficient vapor-liquid contact takes place.

The slot area may be relatively small and the slots located close to the tray floor so that the largest possible amount of liquid may be picked up by the vapor and contacted. Since the major part of the liquid for this type of cap stays close to the tray floor, the caps should be designed so that liquid flows freely without resulting in high liquid gradient. Channel type caps should be applied for this design.

The caps may also be closely spaced and have relatively large slot area. The controlling area in this type of tray is the disengaging area (area between caps) which is smaller than the slot area. The evenly distributed vapor contacts the liquid and pushes it to the upper part of caps or up above the caps. Liquid gradient becomes less of a problem since the liquid flows primarily as a suspended mass above the caps or between the upper part of the caps; if the liquid begins to fall between the caps, it is again pushed up by the vapor and in this manner

eventually reaches the liquid downflow. Liquid gradient and resulting increased jetting becomes more prominent at low vapor velocity, which is a necessity at low tray spacing to avoid excessive liquid entrainment. Liquid gradient also increases with the length of the liquid flow. Consequently, large diameter towers should be built with a large tray spacing. This overcomes the effect of liquid gradient by permitting sufficiently high velocities to lift the liquid up above the caps to the space between the trays without causing entrainment.

In all cases (perforated plate type trays, various cap type tray designs, or any other tray design) jetting must be avoided as much as possible. By proper tray design, jetting may be reduced considerably.

Sudden changes of vapor velocity should be avoided where vapor-liquid contact takes place so that no more kinetic energy is transferred from vapor to liquid than is required to obtain good contact.

Careful design of bubble cap trays to reduce jetting may include such features as the following:

1) Rounded head on bubble caps in order to permit the gradual expansion of vapor from the disengaging area to the area above the caps so that a sudden change in vapor velocity is avoided.

2) Caps and slots located in such a manner that the vapor is not directed against weirs and tower shell to avoid splashes and jetting.

3) Weirs to be designed so that the pseudo depth of liquid is as nearly equal as possible at any point on the tray between the weirs. This assures an even distribution of vapor.

4) Caps to be equally spaced over the entire area between the weirs. If this is not possible, necessary baffles to direct the flow of liquid should be placed so that the vapor emerging from the slots is not directed against the flat surface of the baffles.

5) Trays should be designed so that the vapor velocity is sufficient to "blow" or operate all caps, overcoming differences in liquid load due to liquid gradient and irregularities in design and thereby avoiding liquid dumping through the risers. It may be necessary, in some cases, to extend the height of the chimney to avoid liquid dumping.

Figure 1 and Figure 2 indicate general layouts of a perforated plate type tray and a cap type tray.

Figure 4 shows the design capacity of vapor in cubic feet per second per foot of area above the caps with reasonable liquid loads for tray spacings of 24 and 30-inch. A reasonable liquid load may vary from 10 to 120 gpm per lineal foot of weir. A tray's ability to handle a definite liquid load is, of course, a matter of tray design, including such factors as tower diameter, tray stability, pseudo liquid gradient, available liquid area, etc. The curves illustrate the difference in capacity when employing the suspension Equation (5) and the jetting Equation (15).

The curves are based on data obtained from an experimental 18-inch o.d. glass tower where air was used as vapor and water was used as liquid. The tower was operated under substantially atmospheric pressure. The criterion used to establish the allowable vapor load at various tray spacings was a fixed percentage of water entrainment by the air.

Data was obtained for a cap type tray, equipped with thirteen 2⅞-inch o.d. caps and for perforated plate type trays, without weirs, and of various percentages of free area and size of holes. The data collected in this manner presented the relative capacity of cap type trays and perforated plate type trays at various tray spacings (from 18 to 36-inches).

By comparing these data,[2] with commercial full size towers, operating at maximum or near maximum vapor capacities, it was found that their $C_o$-coefficients were practically identical to the $C_o$-coefficient in the experimental air-water tower, when operating at 2.5 weight percent water entrainment.

The 2.5 percent of entrainment of water in the experimental tower is, of course, no measure of the amount of entrainment in a commercial tower with hydrocarbon vapor and liquids.

A family of curves similar to those shown on Figures 3, 4 and 5, was then constructed from Equations (5) and (15) and the data from the 18-inch outside diameter experimental air-water tower. The allowable vapor velocity of a commercial tower is determined by the quality and yield of the products from the tower.

Figure 3 indicates that the jetting equation (15) permits higher capacities for pressure towers which have small density factors and lower capacities for vacuum towers which have large density factors than is permitted by the suspension Equation (5).

Curves in Figure 3 indicate vapor capacities when employing cap type tray design as indicated in Figure 2.

It should be borne in mind that for different designs of caps and cap layouts, the vapor capacity may change considerably. Poorly designed trays will naturally cause poor separation, even at low capacities. The capacities may be increased above the values given in Figure 3 for carefully designed trays where particular attention has been given to avoid jetting and splashing.

Recent test runs on an 11-foot atmospheric tower and an 18-foot vacuum tower equipped with cap type trays indicate, respectively, 16.5 and 9.1 percent vapor load above that predicted by the jetting equation curve of Figure 3. The density factors were 102 and 1371 for the atmospheric and the vacuum towers, respectively.

Curves in Figure 4 and 5 indicate vapor capacities for perforated plate type trays with free area of 22.63 and 36.62 percent, and tray spacings of 24 and 30 inches. These curves are based on data from the experimental air-water tower referred to above. The suspension Equation (5) is usually applied by the author in the design of high pressure towers because of insufficient data to confirm the validity

**NOMECLATURE**

- $F_a$ — Total Force on Drop, lbs ft/s²
- $K;k$ — Constants
- $\mu$ — Viscosity of Fluid, C.P.
- $D_p$ — Diameter of Particle, ft.
- $D_L$ — Density of Particle (or Liquid), lbs/c.f.
- $D_V$ — Density of Vapor, lbs/c.f.
- $V_o$ — Linear Velocity of Vapor, ft/s (in area above caps)
- $C;C_1;C_o$ — Constants
- $\frac{D_L - D_V}{D_V}$ — Density Factors, Dimensionless
- $W_V$ — Weight of Vapor, lbs/s/sq.ft. of vapor area
- $V$ — Vapor Velocity in Disengaging (or Slot) Area, ft/s
- $V_T$ — Vapor Velocity (in-A), ft/s
- $U_L$ — Volume of Liquid, c.f./s/sq.ft.
- $U_V$ — Volume of Vapor, c.f./s/sq.ft. of area above caps or perforated plate
- $a$ — Disengaging (or Slot) Area, sq.ft.
- $A$ — Vapor Area (or Area Directly Above Caps), sq.ft.
- $B$ — Design Factor
- $H$ — Tray Spacing, ft.
- $g_c$ — Gravitational Conversion Factor, $\frac{\text{lb. mass} \times \text{ft.}}{\text{lb. force} \times \text{s}^2}$
- $g$ — Acceleration of Gravity, ft/s²

of the jetting Equation (15). In the opinion of the author, the available data indicate that Equation (15) should be applied to all towers at any operating pressure.

It may be noted that for a 24-inch tray spacing and a density factor of 180, the perforated plate tray of 36.62 percent free area has a capacity of 229 percent of the capacity of a cap type tray when based on the suspension Equation (5) and 203 percent when based on the jetting Equation (15).

### Greater Vapor Capacity

The major reasons for the greater vapor capacity of the perforated plate are: 1) the even distribution of vapor and liquid, with little or no concentrated jetting and splashing; 2) the large free area (total area of unobstructed holes); 3) no baffles, weirs, caps, etc., to promote local jetting or splashing.

It should be noted that this increased capacity is for the vapor area only. The capacity of the liquid area (downflows) is only slightly greater than that of the bubble cap type tray.

A new design of a perforated plate type tray, "the corrugated perforated plate type tray," as shown in Figure 6, offers an additional increase in vapor capacity compared to the standard or flat perforated plate type tray.[3] This should be particularly advantageous in the design of vacuum towers and other towers in the lower pressure range where the vapor volume is large relative to the liquid volume.

In vacuum towers and similar towers, the volume of liquid load is usually small. Since this liquid load must be distributed over a large vapor area, the problem of good vapor-liquid contact and uniform distribution of the liquid that enters the tray is difficult. However, with the tray design shown in Figure 6, the tower cross-sectional area can be decreased without decreasing the total perforated plate area. The vapor capacity of this type tray is increased considerably without increasing the pressure drop due to vapor passing through the tray, which is an important factor in vacuum towers. The cross-sectional area over which the liquid must be distributed is decreased, thereby increasing the efficiency of vapor-liquid contact, particularly for relatively small volumes of liquid. As with the standard perforated tray, the corrugated perforated tray has no weir. However, the particular design of this corrugated tray offers the effect of a notched weir, which is an added aid in distribution of small volumes of liquid.

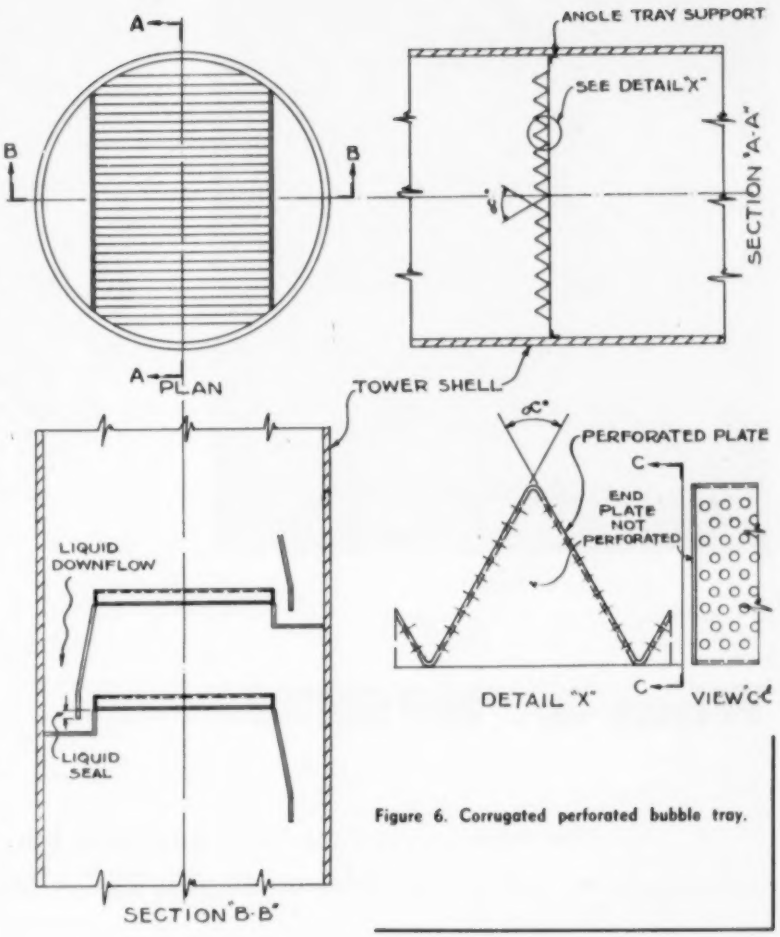



Figure 6. Corrugated perforated bubble tray.

The operation of this tray is similar to that of the standard perforated tray, in that the liquid is kept in suspension above the plate as it is being contacted by the vapor while it flows from the inlet to the outlet of the tray. The major part of the suspended droplets flow above the ridges of the corrugated tray. The droplets are held above the perforated plate itself due to the kinetic energy which is transferred to the liquid from the vapor as the vapor flows from the holes in the plate to the larger area above the corrugated plate. The jetting Equation (12) is proposed for the corrugated tray, as well as for other types of trays.

It is the author's opinion that the efficiency of perforated plate type trays is good when compared with cap type trays, although, at this time, definite data is not available. Visual observation of the operation of the 18-inch outside diameter experimental air-water tower indicated that the vapor load may safely vary from 100 percent (based on curves, Figures 4 and 5) to 37 percent for 30-inch tray spacing and from 100 to 45 percent for 24-inch tray spacing while maintaining good vapor-liquid contact and with little or no liquid dumping through the holes in the perforated plate to the tray below.

Additional experimental work should be undertaken with equipment designed in accordance with the theory and fundamentals of the jetting equations in order to obtain additional data to verify the jetting equation. This data is needed for vacuum towers, as well as for pressure towers, although the jetting equation has long been applied, by the author, to the design of vacuum towers.

#### REFERENCES


[1] Souders, M. Jr. and Brown, G. G., Ind. and Eng. Chem. 26, 98 (1934).

[2] Aksel C. Eld and P. Ostergaard; Effect of Tray Spacing on Entrainment in Fractionating Towers—presented at the Process Distillation Corporation's technical meeting, Philadelphia, March, 1941.

[3] Patent No. 2,591,343—Tray for Fractionating Equipment.

Figure 1.

Figure 2.

# What Is "NPSH"?

**This term is widely used by engineers but the physical significance is understood by only a few of them. Here is a description of "NPSH"**

**Dan R. Rankin**
Peerless Pump Division, Food Machinery and Chemical Corporation,
Los Angeles

AT ANY GIVEN temperature all liquids have a definite pressure at which they boil. Every day we witness the fact that a liquid boils at atmospheric pressure when it reaches a sufficiently high temperature. It is important also to remember that a liquid will boil at any temperature if the pressure is reduced sufficiently. It is the problem of the process and pump application engineers to make certain that there is a sufficient pressure on the fluid being fed to the pump so that the liquid does not boil in the suction system of the pump.

The term "suction lift" is very misleading. No reciprocating gear, turbine vane or centrifugal pump can lift any liquid. It is imperative that the liquid be forced into the pump for it to operate properly. The weight of air in the earth's atmosphere is very frequently used to force liquid into the pump suction and creates the illusion that a pump can lift a liquid. In a closed process system where atmospheric or other pressure in excess of the liquid vapor pressure is not available the liquid level must always be maintained above the pump centerline.

The total energy of a liquid is the sum of potential energy (pressure and elevation) and dynamic energy (velocity head). To maintain a constant total energy any increase in the velocity of a liquid reduces the pressure a corresponding amount. In order for a pump to operate, the pressure pushing the liquid into the pump must overcome the static elevation, the friction and turbulence losses in the suction line, accelerate the fluid, and maintain sufficient pressure to keep the fluid in the suction line from boiling.

We are all familiar with the realistic comment made in many cases of crisis that, "Things must get worse before they will get better." This is equally true of the suction conditions of a centrifugal pump. After fluid has finally been forced through the suction system to the suction flange of a pump a pressure drop occurs within the pump before the impeller can increase the pressure.

### Why a Pump Requires a Positive Suction Head

A pressure drop occurs between the pump suction flange and the minimum pressure point within the pump impeller, Figure 5, because of:

1) An increase in the velocity between the suction flange and entrance of the impeller vanes.

2) Friction and turbulence losses between the suction flange and entrance to the impeller vanes.

It is impossible to design a centrifugal pump in which there is no pressure drop between the suction flange and

Figure 3.

Figure 4.

## Here's the Explanation of Cavitation Pictures

**On process pumps which are designed with top suction manifolds it is possible to install plastic plates at the suction of the pump and by means of strobotactic lights which flash on and off at the same rate as the rotation of the pump, visualize the flow of fluid around the entrance of the impeller vanes. Figure 1 shows a picture of such a pump with the plastic end plate removed so that the impeller can be seen through the suction portion of the pump case.**

**Initial stages of cavitation are indicated on Figure 2. It is noted that vapor is beginning to form on the entrance edges of the vanes. Little noise or reduction in pump performance is noted in this stage of cavitation. Impeller vanes may show some pitting after extended operation under these conditions especially if there is any tendency toward corrosion present.**

**Figure 3 shows the increased formation of vapor which extends over a larger portion of the entrance of the impeller vanes as a result of increasing the suction lift on the pump which decreases the pressure at this area. Normally, some noise would be evident in the pump and a reduction in efficiency and head developed by the pump would become apparent at this stage.**

**Figure 4 indicates severe cavitation at the impeller vanes as the pressure in the pump is further decreased by further increasing the suction lift. Although the pump will still operate under these conditions, it will be noisy, have a reduced head and efficiency. Vibration would undoubtedly be noticeable and severe pitting would occur on the impellers if operated for an extended period of time under these conditions.**

the minimum pressure point which normally occurs at the entrance to the impeller vanes. All pump systems must have a positive suction pressure sufficiently high to overcome this pressure drop within the pump and to keep the fluid from boiling at the pumping temperature.

### Pumping Water at Sea Level

Figure 6 is a schematic chart showing a general condition of pump operation where the energy at the surface of the liquid source is appreciably greater than the vapor pressure of the liquid being handled. A specific example of this condition is pumping water at room temperature where the liquid source is under atmospheric pressure at sea level. The energy indicator to the left shows the total energy at the surface of a water source at sea level due to atmospheric pressure is approximately 34 feet. Of this 34 feet, approximately one foot must be maintained at all times to keep the water from boiling. This leaves essentially 33 feet of energy at the surface of any normal water source at sea level to force the liquid into the pump.

A pump is shown at the right of the figure with its center line above the liquid level. The total useful energy between the center line of the pump and the height to which the atmospheric pressure holds the water is indicated by the energy indicating tube attached to the suction of the pump. Note the useful pressure which is not available to push the liquid into the pump because of the position of the pump above the liquid level. The pressure at the suction flange of the pump is further reduced by friction and turbulence losses in the suction line and by the energy which must go into accelerating the fluid.

If an absolute pressure gauge were attached to the suction of the pump exactly as indicated in Figure 6 the liquid would stand at the height indicated, designating the useful pressure at this point. As long as the useful pressure above the center line of the pump is sufficient to overcome the pressure drop within the pump, caused by the increase in velocity and the friction between the suction flange and the entrance to the impeller vanes, the pump will continue to operate properly.

### Pumping Liquids With High Vapor Pressure From Open Tanks

Figure 7 represents a pumping system for a fluid with high vapor pressure such as acetone with the tank opened to the atmosphere at sea level. The total energy at the surface of the liquid is the same as indicated for water in Figure 6. The liquid would rise to the level indicated in an absolute pressure gauge standing in the liquid source. Thus although the total energy at the surface of the acetone would be identical to that of water, the useful pressure to force the fluid into the pump would be appreciably reduced.

Looking at a pump installation identical to that in Figure 6, it is noted that the same friction and velocity pressure losses would occur in the case of acetone assuming it has essentially the same viscosity as water. However, the useful pressure available to force the fluid into the pump is much smaller in this example because of the

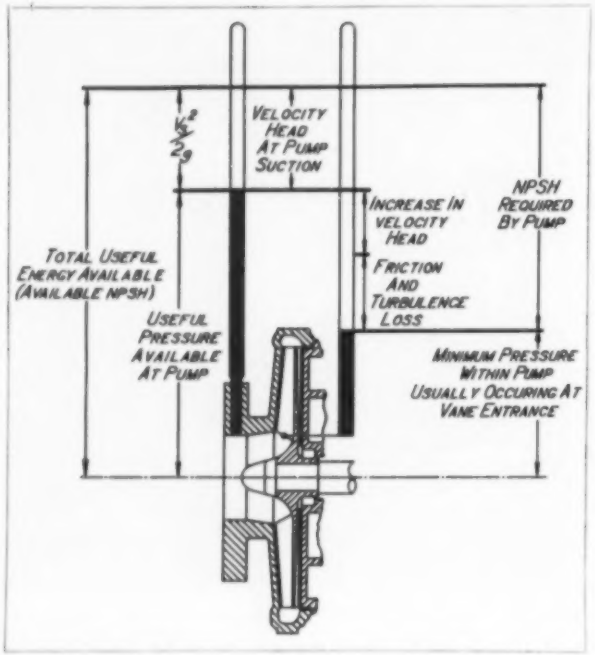

$\frac{V^2}{2g}$
VELOCITY HEAD AT PUMP SUCTION
INCREASE IN VELOCITY HEAD
NPSH REQUIRED BY PUMP
FRICTION AND TURBULENCE LOSS
TOTAL USEFUL ENERGY AVAILABLE (AVAILABLE NPSH)
USEFUL PRESSURE AVAILABLE AT PUMP
MINIMUM PRESSURE WITHIN PUMP USUALLY OCCURING AT VANE ENTRANCE

**Figure 5. Relation between available NPSH in a system and that required by a pump.**

large amount of pressure which is required to keep the fluid in the liquid state. This is the reason why a pump handling a fluid with a higher vapor pressure than that of water at room temperature cannot be located as high above the surface of the liquid to be pumped.

### What Effect Has Altitude on Pump Suction Conditions?

In these days of flying we are all conscious of the fact that the weight of the air in the earth's atmosphere becomes less at high altitudes. At 20,000-foot elevation the atmospheric pressure is approximately 15½ feet of water. Assuming that a pump was installed at this altitude, the pressure on a water source at room temperature would be 15½ feet. Since the total energy to force the water into the pump must be available at the liquid source and with the same vapor pressure as with our sea level example in Figure 6, the remaining useful pressure is only 14.6 feet. If we locate the pump at the same distance above the water and try to pump the same amount of water, there will be the same loss of useful pressure due to pump location, friction in the suction line, and acceleration of the fluid. The remaining useful pressure to force the fluid into the pump would be entirely inadequate and the pump would not operate under these conditions until it was lowered closer to the liquid source. See Figure 8.

### What About Liquids at the Boiling Point?

Under certain conditions it is not possible for the pump location to be above the liquid source. As the vapor pressure increases in relation to the pressure on the surface of the liquid source it is necessary to bring the center line of the pump nearer and nearer the source of the liquid until finally the pump must be installed below that liquid source.

The most common installation in process pump application is where the tank is not open to atmospheric pressure but is completely enclosed in a vessel and is maintained at or very near its boiling point. In other words, the vapor pressure above the fluid is the same as that on the surface of the liquid source. In such a case the total energy at the liquid surface simply represents the vapor pressure of the fluid which keeps it in liquid state. There is no additional pressure available to push this liquid into the pump. Therefore, the pump location must be below the surface of this liquid as indicated in Figure 9. In this case the only useful energy available to force the fluid into the pump is that resulting from the difference in location between the center line of the pump shaft and the surface of the boiling liquid. This distance must be sufficient to overcome the friction in the line, accelerate the fluid, and overcome the pressure drop which occurs between the suction flange of the pump and the entrance to the impeller vanes.

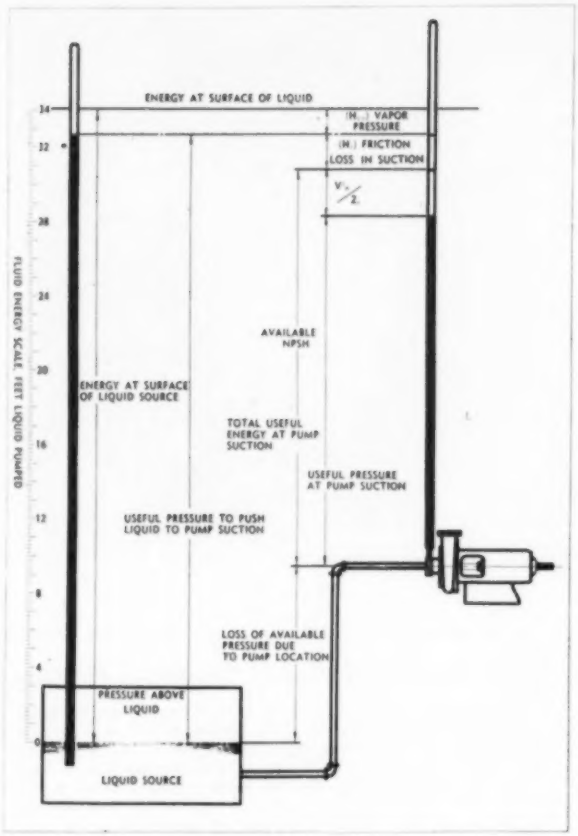



**Figure 6. Pumping water at sea level.**

### Now, What Is NPSH?

In the above discussion we have used only absolute pressure and energy values. Ne now want to identify these values with the term "NPSH."

"The net positive suction head (NPSH) is the total suction head in feet of liquid absolute determined at the suction nozzle and referred to datum, less the vapor pressure of the liquid in feet absolute."

The NPSH required by a pump is equivalent to the drop in pressure between the suction flange of the pump and the entrance to the impeller vanes plus the velocity head at the pump suction. This is indicated graphically in Figure 5 and represents the net positive suction head required by the pump for proper operation. Any system

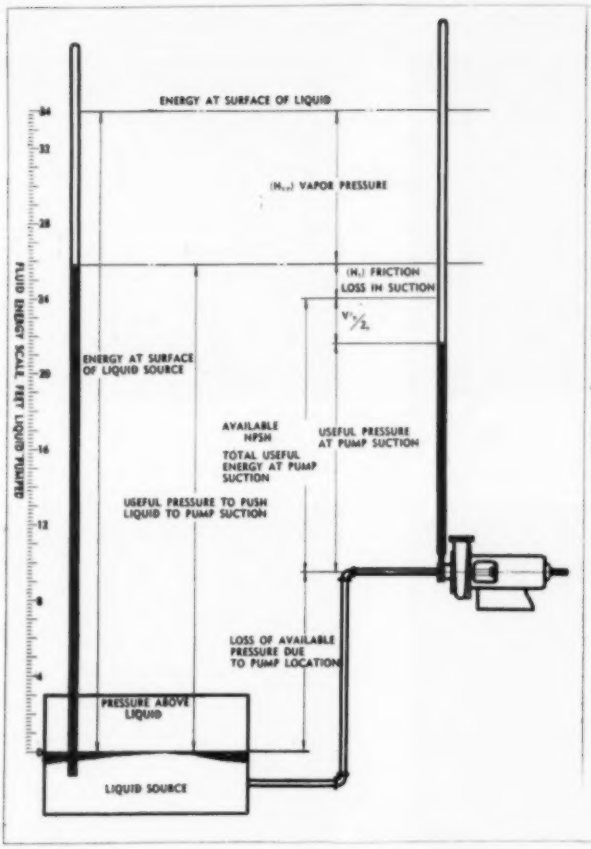

ENERGY AT SURFACE OF LIQUID
(H$_{vp}$) VAPOR PRESSURE
(H$_s$) FRICTION LOSS IN SUCTION
V$^2$/2g
ENERGY AT SURFACE OF LIQUID SOURCE
AVAILABLE NPSH
USEFUL PRESSURE AT PUMP SUCTION
TOTAL USEFUL ENERGY AT PUMP SUCTION
USEFUL PRESSURE TO PUSH LIQUID TO PUMP SUCTION
LOSS OF AVAILABLE PRESSURE DUE TO PUMP LOCATION
PRESSURE ABOVE LIQUID
LIQUID SOURCE
FLUID ENERGY SCALE, FEET LIQUID PUMPED

Figure 7. Pumping liquid with high vapor pressure at sea level.

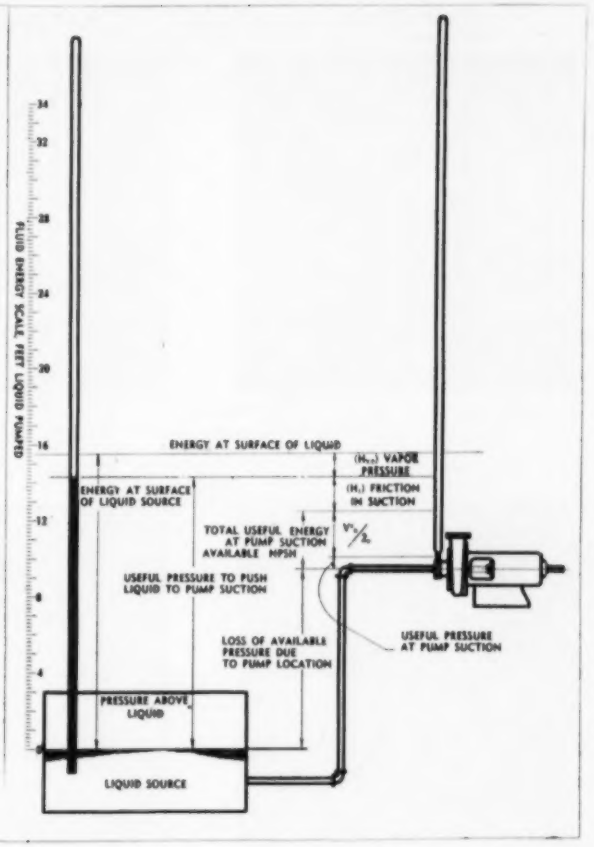

ENERGY AT SURFACE OF LIQUID
(H$_{vp}$) VAPOR PRESSURE
ENERGY AT SURFACE OF LIQUID SOURCE
(H$_s$) FRICTION IN SUCTION
TOTAL USEFUL ENERGY AT PUMP SUCTION AVAILABLE NPSH
V$^2$/2g
USEFUL PRESSURE TO PUSH LIQUID TO PUMP SUCTION
LOSS OF AVAILABLE PRESSURE DUE TO PUMP LOCATION
USEFUL PRESSURE AT PUMP SUCTION
PRESSURE ABOVE LIQUID
LIQUID SOURCE
FLUID ENERGY SCALE, FEET LIQUID PUMPED

Figure 8. Example of improper pump location when pumping water at 20,000 feet.

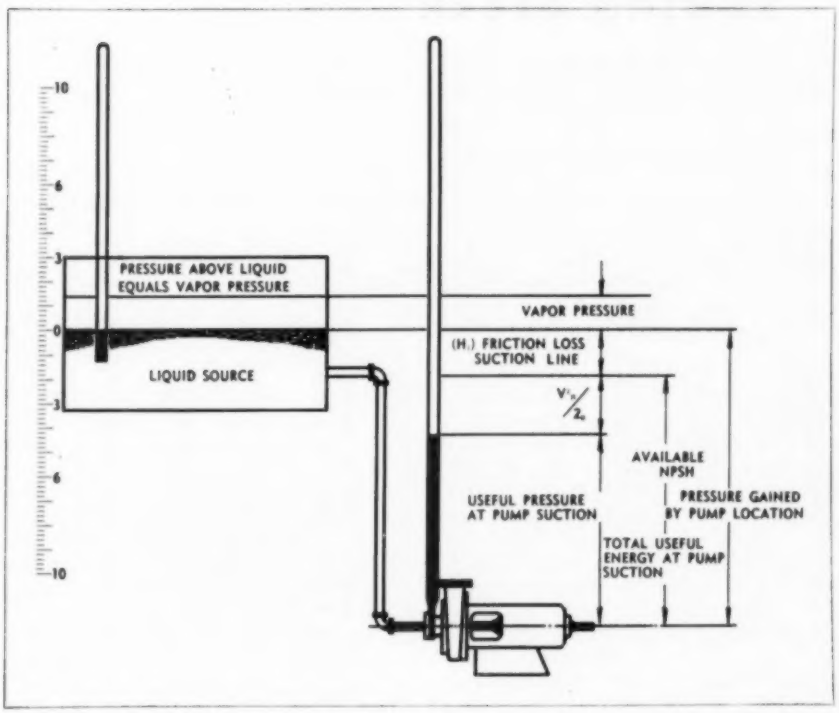


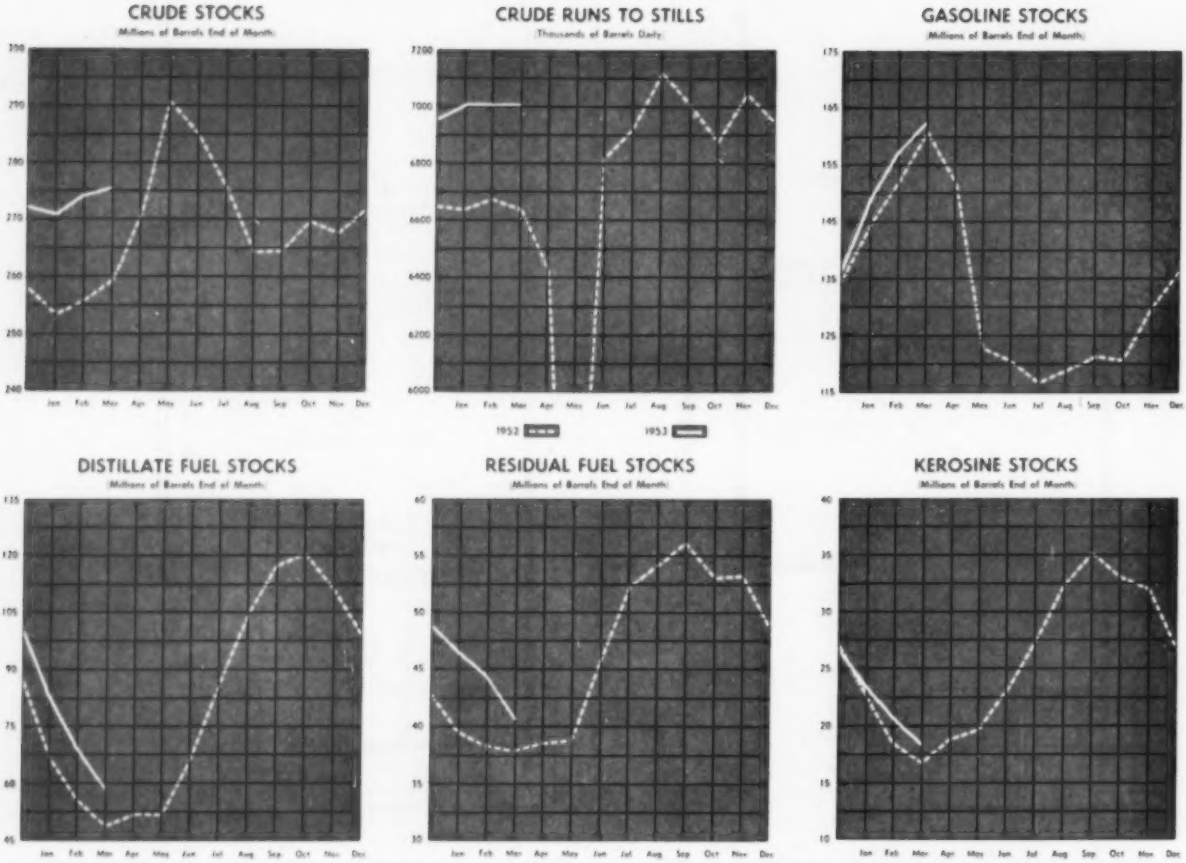

Figure 9. Typical pumping installation when pumping process fluid in a closed system.

must be so designed that the available NPSH of the system is equal to or exceeds the NPSH required by the pump.

The available NPSH of various systems is indicated in Figure 6, 7, 8 and 9 and is identical to the total useful energy at the pump suction.

Since the NPSH required by a pump is a fraction of losses within the pump and the velocity of fluid in the pump, it is dependent upon the speed of operation, the amount of liquid being handled by the pump, and the design of the whole entrance section of the pump including the vane angles and thickness.

Editor's Note: *An understanding of the physical significance of NPSH is important in applying numerical formulae to pumping problems. We have asked Dan R. Rankin to prepare a subsequent paper to cover the solution of specific application problems. Look for this article in an early issue.*




# Taking Stock

**Cecil W. Smith**
Economics Editor

(DATA IN THOUSANDS OF BARRELS)

| MONTH | CRUDE OIL | | | GASOLINE | | KEROSINE | | DISTILLATE FUEL | | RESIDUAL FUEL | | DAILY IMPORTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Production Daily | Runs to Stills Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Crude Oil | Total Oils |
| **1951:** | | | | | | | | | | | | | |
| November | 6,272 | 6,609 | 261,100 | 3,130 | 122,723 | 403 | 32,116 | 1,358 | 101,666 | 1,304 | 46,491 | 425 | 802 |
| December | 6,182 | 6,646 | 255,783 | 3,150 | 134,867 | 393 | 27,088 | 1,442 | 86,619 | 1,313 | 42,853 | 423 | 834 |
| **1952:** | | | | | | | | | | | | | |
| January | 6,217 | 6,640 | 254,007 | 3,094 | 144,339 | 421 | 22,679 | 1,456 | 66,969 | 1,338 | 39,523 | 488 | 951 |
| February | 6,367 | 6,673 | 255,900 | 3,109 | 151,912 | 370 | 18,530 | 1,528 | 55,369 | 1,322 | 38,295 | 491 | 940 |
| March | 6,388 | 6,640 | 259,126 | 3,069 | 160,689 | 386 | 16,817 | 1,400 | 48,750 | 1,274 | 37,971 | 510 | 947 |
| April | 6,429 | 6,435 | 270,679 | 2,995 | 151,890 | 366 | 18,855 | 1,312 | 51,634 | 1,253 | 38,561 | 539 | 922 |
| May | 5,107 | 4,905 | 290,813 | 2,295 | 123,656 | 229 | 19,614 | 982 | 51,648 | 979 | 38,821 | 545 | 951 |
| June | 6,197 | 6,825 | 285,964 | 3,169 | 120,166 | 317 | 23,061 | 1,455 | 65,911 | 1,228 | 45,688 | 581 | 901 |
| July | 6,093 | 6,927 | 275,951 | 3,295 | 116,566 | 358 | 27,387 | 1,475 | 85,775 | 1,237 | 52,245 | 597 | 892 |
| August | 6,219 | 7,118 | 264,368 | 3,377 | 118,592 | 375 | 32,401 | 1,514 | 104,257 | 1,252 | 54,061 | 632 | 879 |
| September | 6,518 | 7,017 | 264,723 | 3,428 | 120,991 | 350 | 35,021 | 1,502 | 117,252 | 1,230 | 56,200 | 615 | 902 |
| October | 6,518 | 6,883 | 269,776 | 3,301 | 120,062 | 352 | 33,289 | 1,458 | 120,721 | 1,203 | 53,052 | 643 | 1,038 |
| November | 6,487 | 7,049 | 267,852 | 3,416 | 129,509 | 393 | 32,199 | 1,510 | 116,096 | 1,299 | 53,069 | 624 | 984 |
| December | 6,634 | 6,952 | 271,928 | 3,361 | 136,028 | 421 | 26,842 | 1,509 | 99,582 | 1,302 | 48,706 | 603 | 1,165 |
| **1953:** | | | | | | | | | | | | | |
| January | 6,555 | 7,042 | 272,250 | 3,384 | 150,518 | 433 | 23,292 | 1,528 | 80,655 | 1,307 | 45,910 | 616 | 1,135 |
| February | 6,562 | 6,969 | 273,589 | 3,379 | 157,873 | 404 | 20,468 | 1,505 | 67,167 | 1,275 | 44,178 | 586 | 1,066 |
| March | 6,453 | 7,024 | 275,409 | 3,284 | 162,609 | 380 | 18,564 | 1,475 | 59,743 | 1,285 | 40,572 | 637 | 1,074 |
| **March, 1953—Change:** | | | | | | | | | | | | | |
| In Month | —109 | +55 | +1,820 | —95 | +4,736 | —24 | —1,904 | —30 | —7,424 | +10 | —3,606 | +51 | +8 |
| In Year | +65 | +384 | +16,283 | +215 | +1,920 | —6 | +1,747 | +75 | +10,993 | +11 | +2,601 | +127 | +127 |
| **Week Ended:** | | | | | | | | | | | | | |
| 4-18-53 | 6,281 | 6,686 | 276,691 | 3,248 | 157,942 | 379 | 19,685 | 1,366 | 61,738 | 1,243 | 39,855 | 481 | 933 |
| 4-19-52 | 6,366 | 6,501 | 262,791 | 3,043 | 157,392 | 389 | 17,321 | 1,303 | 49,358 | 1,280 | 36,828 | 620 | 980 |

**Source:** Data for last two months from API; prior monthly data from Bureau of Mines.

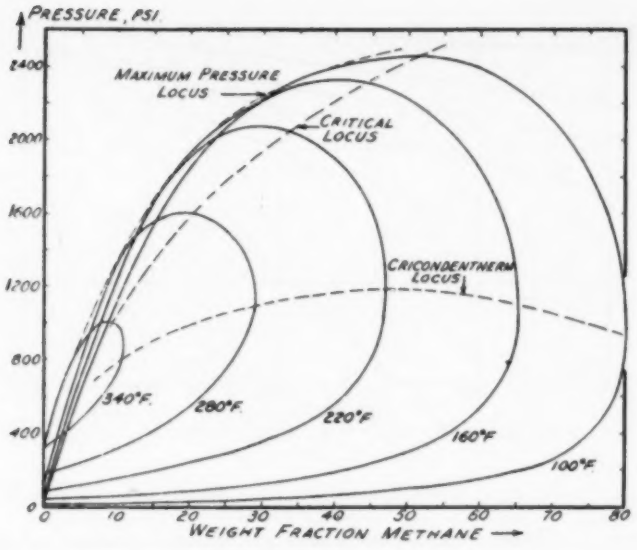



Figure 1. Pressure—Composition Diagram, Methane—n-Pentane System.[10]

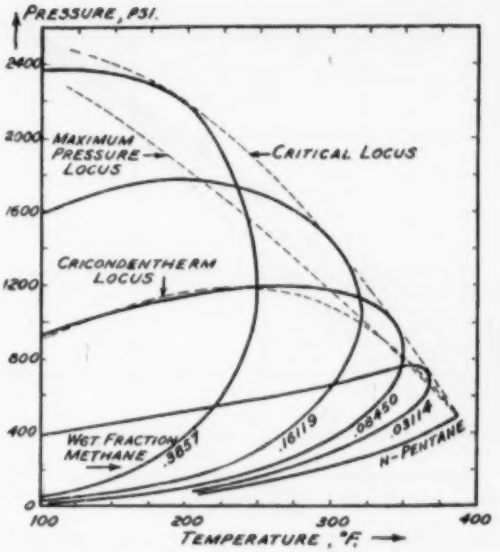



Figure 2. Pressure—Temperature Diagram, Methane —n-Pentane Systems.[10]

# Correlating Total Pressures Of Binary Systems

## A new method using reference systems at corresponding states

**Roger Gilmont, Theodore Roszkowski and Donald F. Othmer**
Polytechnic Institute of Brooklyn,
Brooklyn

THE RESULTS of the new correlation lead to the development of a generalized method for the prediction of total pressures of any paraffin binary system. The correlation is an extension of the well-known method for correlating vapor pressures by comparison against a reference substance at the same temperature.[7] Many properties other than vapor pressures have also been correlated by this simple, straight line technique.[11, 12]

The method of plotting is as follows: Select a sheet of standard logarithmic paper and calibrate on the X axis (against the logarithmic graduations) even values of temperatures corresponding to the vapor pressures of a reference liquid; erect temperature ordinates at these points; and plot on these temperature ordinates the corresponding values of vapor pressure data in question on the standard graduations indicated on the Y axis. Lines substantially straight over wide ranges are obtained for all types of vapor pressure data investigated. This method has been further elaborated to incorporate the principle of corresponding states enabling one to achieve accurate correlation up to the critical point.[8] Application to other properties as well as total pressure of binary systems has likewise been made;[9] and, in addition, corresponding states have been used to extend the correlation of binary systems to the critical point.[10] Although the results of this last correlation appeared to be quite adequate for most systems, some variation occurred near the critical region especially for binary systems of high rela-

Dr. Gilmont also is technical director of The Emil Greiner Company, New York. Mr. Roszkowski's present address is The Lummus Company, New York.

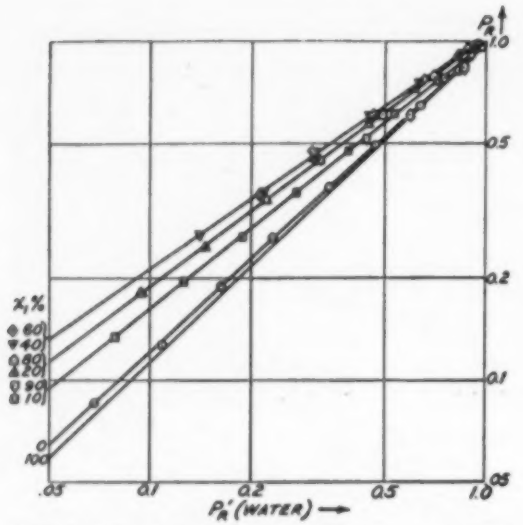



Figure 3. Reduced total pressure plot, Propane—n-Pentane System against Water.[10]

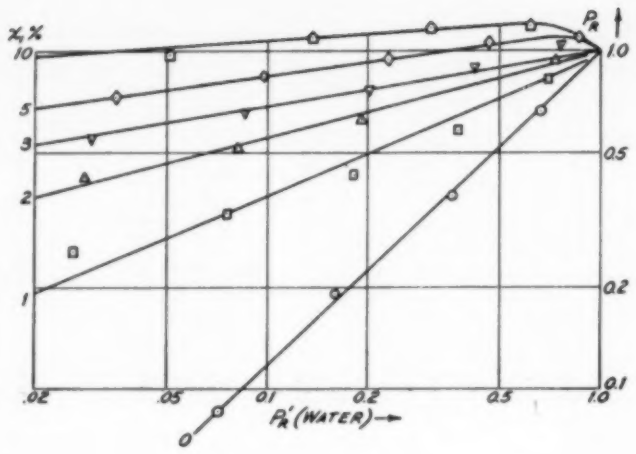



Figure 4. Reduced total pressure plot, Methane—n-Pentane System against Water.[10]

tivity volatility such as paraffin systems consisting of lower members of the series.

## Critical Condition for a Binary Mixture

In order to explain the above method of correlation as well as the newer one to be described in this paper, the concept of critical conditions for a binary system will first be discussed.

The critical point for a two-phase heterogeneous system in equilibrium is, according to Gibbs, that point at which the coexistent phases just disappear and become one and the same. For a pure liquid in equilibrium with its vapor, this point is clearly defined as that temperature at which the physical boundary between the liquid and vapor just disappears and the two phases become one and the same—namely, the gas phase. In the case of a binary mixture of two pure liquids, the critical point becomes a function of composition and is defined in exactly the same way for a mixture of definite composition. However, as the vapor composition is different from the liquid composition in which it is in equilibrium, two curves result of pressure against composition for a given temperature—that is, one for the vapor and one for the liquid. At the critical point both compositions become identical.

In Figure 1 the pressures against composition curves are shown for the liquid and vapor at different temperatures for the system methane—n-pentane.[16] The critical point varies with composition; its locus is shown by a dotted line passing through the maximum points of the isotherms. For a given isotherm of Figure 1, the liquid and vapor compositions in equilibrium at a given pressure are the intersections of the horizontal or constant pressure line and the isotherm; the liquid composition is the left and the vapor composition the right portion of the curve. As the critical point is approached, the vapor and liquid compositions approach each other until they become identical at the maximum point of the curve.

**TABLE 1**
**Calculation of Reduced Properties, Propane-n-Pentane**
(Component 1: Propane)

| x1% | P, Lb./Sq. In. | Temp., °F. | Temp., °R. | 1/Tr | P'r (Water) | Pr |
|---|---|---|---|---|---|---|
| 0 | 42 | 160 | 620 | 1.372 | 0.0680 | 0.0851 |
| | 63 | 190 | 650 | 1.309 | 0.108 | 0.1275 |
| | 93 | 220 | 680 | 1.252 | 0.163 | 0.1882 |
| | 130 | 250 | 710 | 1.197 | 0.242 | 0.263 |
| | 183 | 280 | 740 | 1.150 | 0.342 | 0.371 |
| | 246 | 310 | 770 | 1.106 | 0.469 | 0.498 |
| | 323 | 340 | 800 | 1.063 | 0.637 | 0.653 |
| | 412 | 370 | 830 | 1.026 | 0.835 | 0.834 |
| | 494 | 392 | 852 | 1.0 | 1.0 | 1.0 |
| 10 | 72 | 160 | 620 | 1.352 | 0.0785 | 0.135 |
| | 104 | 190 | 650 | 1.289 | 0.126 | 0.1956 |
| | 141 | 220 | 680 | 1.232 | 0.188 | 0.265 |
| | 191 | 250 | 710 | 1.180 | 0.273 | 0.359 |
| | 255 | 280 | 740 | 1.132 | 0.388 | 0.479 |
| | 328 | 310 | 770 | 1.089 | 0.530 | 0.617 |
| | 414 | 340 | 800 | 1.047 | 0.715 | 0.778 |
| | 528 | 370 | 826 | 1.010 | 0.935 | 0.992 |
| | 532 | 378 | 838 | 1.0 | 1.0 | 1.0 |
| 20 | 103 | 160 | 620 | 1.327 | 0.0940 | 0.182 |
| | 145 | 190 | 650 | 1.267 | 0.146 | 0.256 |
| | 193 | 220 | 680 | 1.210 | 0.221 | 0.341 |
| | 255 | 250 | 710 | 1.160 | 0.317 | 0.451 |
| | 327 | 280 | 740 | 1.112 | 0.448 | 0.578 |
| | 411 | 310 | 770 | 1.069 | 0.610 | 0.726 |
| | 510 | 340 | 800 | 1.028 | 0.815 | 0.900 |
| | 566 | 363 | 823 | 1.0 | 1.0 | 1.0 |
| 40 | 166 | 160 | 620 | 1.272 | 0.141 | 0.268 |
| | 222 | 190 | 650 | 1.213 | 0.217 | 0.359 |
| | 293 | 220 | 680 | 1.160 | 0.317 | 0.473 |
| | 377 | 250 | 710 | 1.112 | 0.448 | 0.608 |
| | 473 | 280 | 740 | 1.066 | 0.628 | 0.763 |
| | 574 | 310 | 770 | 1.025 | 0.840 | 0.927 |
| | 619 | 329 | 789 | 1.0 | 1.0 | 1.0 |
| 60 | 230 | 160 | 620 | 1.215 | 0.213 | 0.352 |
| | 309 | 190 | 650 | 1.160 | 0.317 | 0.472 |
| | 400 | 220 | 680 | 1.108 | 0.460 | 0.612 |
| | 508 | 250 | 710 | 1.061 | 0.650 | 0.776 |
| | 625 | 280 | 740 | 1.018 | 0.880 | 0.955 |
| | 654 | 293 | 753 | 1.0 | 1.0 | 1.0 |
| 80 | 300 | 160 | 620 | 1.152 | 0.338 | 0.451 |
| | 408 | 190 | 650 | 1.099 | 0.492 | 0.613 |
| | 530 | 220 | 680 | 1.050 | 0.700 | 0.795 |
| | 659 | 250 | 710 | 1.006 | 0.962 | 0.990 |
| | 666 | 254 | 714 | 1.0 | 1.0 | 1.0 |
| 90 | 337 | 160 | 620 | 1.114 | 0.440 | 0.518 |
| | 462 | 190 | 650 | 1.062 | 0.645 | 0.708 |
| | 608 | 220 | 680 | 1.017 | 0.885 | 0.934 |
| | 651 | 232 | 692 | 1.0 | 1.0 | 1.0 |
| 100 | 382 | 160 | 620 | 1.072 | 0.593 | 0.614 |
| | 523 | 190 | 650 | 1.022 | 0.855 | 0.841 |
| | 622 | 206 | 666 | 1.0 | 1.0 | 1.0 |

Other critical loci also occur, such as the maximum pressure locus and the critical condentherm locus. The maximum pressure locus is readily interpreted by Figure 2, which is a plot of pressure against temperature for lines of constant composition, called isosteres. As the critical locus is defined by those compositions occurring at maximum pressures for constant temperatures in Figure 1, it becomes the envelope of the isosteres in Figure 2. Thus, for a constant temperature, the composition which corresponds to a maximum pressure lies on this envelope. In a reciprocal manner, the maximum pressure locus is shown in Figure 2 by a dotted line through the maximum pressure points of the isosteres, but it is shown by an envelope of the isotherms in Figure 1 inasmuch as it is defined as the maximum pressure attainable by a constant composition phase. For this particular system, the maximum pressure occurs for the liquid phase, as the liquid curve is that portion of the isostere to the left of the critical locus.

The critical condentherm locus defines those pressures at which the isotherm reaches a maximum composition or at which the isostere reaches a maximum temperature. It is interpreted readily by means of Figure 1 as the maximum composition at which con-

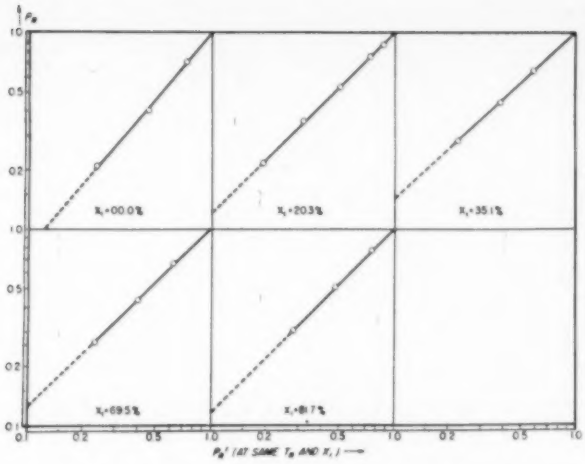


Figure 5. New reduced total pressure plot, Propane—i-Pentane against Propane—n-Butane.

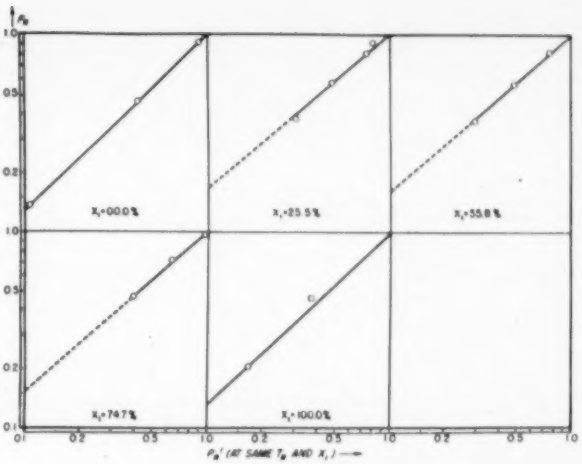


Figure 6. New reduced total pressure plot, Propane—i-Pentane against n-Pentane—n-Heptane.

densation will take place if the vapor is compressed isothermally. All three loci coincide, if the pressure-composition diagram yields isotherms in which the vapor and liquid curves meet in points that are maximum compositions as well as maximum pressures. This is the case for a system such as ethanol-water.

In spite of the complications which occur in the critical region for multicomponent systems, the critical state still retains the definition according to Gibbs; the calculations of reduced properties in the correlations described in this paper are based on this definition.

The reduced properties are defined as always; the reduced temperature is the given temperature divided by the critical temperature; the reduced pressure is the given pressure divided by the critical pressure. The reduced latent heat is defined as the latent heat at the experimental temperature divided by the critical temperature.

## Total Pressure Plot

Following the previous technique,[8] the logarithm of the reduced total pressure of the binary system at constant composition is plotted against the logarithm of the reduced pressure of a reference substance (which may be one of the components of the system); both reduced pressures being taken at the same reduced temperature. This gives a series of lines of constant compositions taken at suitable values to describe the system completely. All of these lines pass through the origin, which represents the critical point for each isostere.

The slope of each total pressure line in this reduced plot for a binary system is equal to the ratio of the reduced latent heat of the mixture in question to the reduced latent heat of the reference substance.

To make this plot, the critical pressure and temperature must be known for the mixture at the composition of each different isostere. Unfortunately, there are very few binary systems for which such information is available experimentally. Moreover, no simple relation exists between these variables and the critical constants for the pure components, as is apparent from the systems for which data are available.

**TABLE 2**
**Calculation of Reduced Properties, Methane-n-Pentane**
(Component 1: Methane)

| $x_1$% | P, Lb./ Sq. In. | Temp., °F. | Temp., °R. | $1/T_R$ | $P'_R$ (Water) | $P_R$ |
|---|---|---|---|---|---|---|
| 10 | 1090 | 100 | 560 | 1.412 | 0.0505 | 0.977 |
| | 1230 | 160 | 620 | 1.277 | 0.136 | 1.103 |
| | 1320 | 220 | 680 | 1.163 | 0.309 | 1.183 |
| | 1330 | 280 | 740 | 1.069 | 0.610 | 1.192 |
| | 1115 | 332 | 792 | 1.0 | 1.0 | 1.0 |
| 5 | 595 | 100 | 560 | 1.462 | 0.350 | 0.734 |
| | 692 | 160 | 620 | 1.322 | 0.0975 | 0.853 |
| | 774 | 220 | 680 | 1.205 | 0.230 | 0.956 |
| | 864 | 280 | 740 | 1.108 | 0.460 | 1.066 |
| | 892 | 340 | 800 | 1.023 | 0.852 | 1.111 |
| | 810 | 360 | 820 | 1.0 | 1.0 | 1.0 |
| 3 | 378 | 100 | 560 | 1.486 | 0.0295 | 0.552 |
| | 452 | 160 | 620 | 1.341 | 0.0855 | 0.660 |
| | 525 | 220 | 680 | 1.222 | 0.202 | 0.767 |
| | 616 | 280 | 740 | 1.123 | 0.416 | 0.899 |
| | 718 | 340 | 800 | 1.040 | 0.752 | 1.050 |
| | 685 | 372 | 832 | 1.0 | 1.0 | 1.0 |
| 2 | 263 | 100 | 560 | 1.492 | 0.0282 | 0.424 |
| | 322 | 160 | 620 | 1.348 | 0.081 | 0.519 |
| | 390 | 220 | 680 | 1.230 | 0.192 | 0.628 |
| | 475 | 280 | 740 | 1.130 | 0.394 | 0.765 |
| | 595 | 340 | 800 | 1.044 | 0.727 | 0.959 |
| | 620 | 377 | 837 | 1.0 | 1.0 | 1.0 |
| 1 | 142 | 100 | 560 | 1.502 | 0.0262 | 0.2545 |
| | 185 | 160 | 620 | 1.357 | 0.0755 | 0.332 |
| | 240 | 220 | 680 | 1.237 | 0.182 | 0.430 |
| | 326 | 280 | 740 | 1.137 | 0.373 | 0.584 |
| | 466 | 340 | 800 | 1.051 | 0.695 | 0.835 |
| | 558 | 382 | 842 | 1.0 | 1.0 | 1.0 |
| 0 | 15.7 | 100 | 560 | 1.510 | 0.0248 | 0.0318 |
| | 42.5 | 160 | 620 | 1.365 | 0.0715 | 0.086 |
| | 94.9 | 220 | 680 | 1.254 | 0.160 | 0.192 |
| | 186 | 280 | 740 | 1.143 | 0.360 | 0.376 |
| | 329 | 340 | 800 | 1.058 | 0.661 | 0.665 |
| | 494 | 387 | 847 | 1.0 | 1.0 | 1.0 |

Kay's rule[2] which assumes that the critical value for the mixture is the average of those for the pure components weighted according to mole fraction, is about as applicable as Raoult's law, of which it is a specific case.

*PROPANE-n-PENTANE.* The data of Sage and Lacey[14] for this system are plotted against water as the reference substance in Figure 3 from data collected and calculated in Table 1. For this system the slope of the lines of constant composition passes through a minimum. This is an indication that at a given reduced temperature (or pressure) the reduced latent heat of evaporation of the system as a function of composition passes through a minimum. In the case of the system Methane-n-pentane discussed below no such minimum is apparent.

*METHANE-n-PENTANE.* The other system plotted is from the data reported by Sage et al.[16] The reduced total pressure plot against water as the reference substance is shown in Figure 4, plotted from data tabulated in Table 2. (It was found convenient to use log coordinates for both the pressure and composition in the preliminary pressure-composition diagram giving lines with little or no curvature; this made isosteric interpolation simple and accurate.) The lines of Figure 4 curve as the critical point is approached. However, when there is considered the extreme difference in volatility between the components and the fact that the vapor-liquid equilibria data are all in the critical region, the correlation may be considered quite good and should be adequate for most engineering needs. The best straight lines through the observed points up to the major curva-

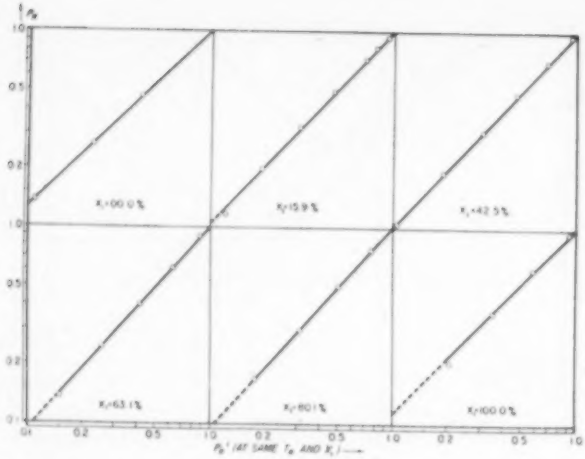


Figure 7. New reduced total pressure plot, Propane—i-Pentane against n-Butane—n-Heptane.

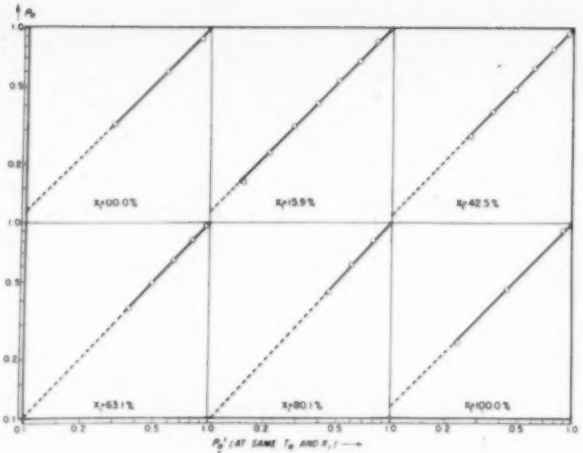


Figure 8. New reduced total pressure plot, Propane—n-Pentane against n-Butane—n-Heptane.

ture are drawn to show the extent of the deviations.

## New Plot

The reason for curvature in the above total pressure plot, which becomes more apparent as the critical region is approached and as the relative volatility increases, is fairly obvious if there is studied the shape of the pressure-temperature curve for a binary system as compared to a pure component. Thus, in Figure 2, the P-T curve for pure n-pentane consists of a single line above which only the liquid phase occurs and below which only the vapor phase exists. Along the line, both vapor and liquid may exist in equilibrium. For one of the mixtures, say .03114 weight fraction methane, the P-T curve consists of two branches one for liquid (upper part) and one for vapor (lower part). In correlating the liquid curve of the mixture against the vapor-liquid curve of the pure component, the curvature of the former deviates more and more from the latter as the critical point is approached. This deviation causes the curvature in the straight line plot of Figure 4 in the critical region.

The first attempt to circumvent the difficulty was based on the idea of utilizing an average composition of vapor and liquid to describe the P-T curve of the binary mixture. Thus, in Figure 1, the isotherms, each consisting of a liquid and vapor curve meeting at the critical point, were replaced by single curves passing through the average of vapor and liquid composition at each pressure and ending at the critical point. A cross plot of these lines replaced Figure 2 with a series of single P-T curves for each average composition, which were then correlated against a pure component, such as water. Although this procedure produced an improvement in the previous method, curvatures still persisted in the critical region and further refinement was attempted.

The second attempt was based on the idea of comparing the total pressure of one binary system against that of a second binary system as the standard. Reduced pressures of the first system were compared against the reduced pressures of the standard system at the same liquid compositions and reduced temperatures. For some systems this method produced straight lines as desired but for other systems curvature still persisted in the critical region. The reason for this became evident when the shape of the isotherms for binary systems with different relative volatilities were considered. As the relative volatility increases the isotherms become "fatter," that is, the relative distance between liquid and vapor branches increases.

**TABLE 3**
**Comparisons Made**

| SYSTEMS* | Fig. No. | Table No. | R | Ref. No. |
|---|---|---|---|---|
| 1. Propane, i-pentane | 5 | 4 | 1.25 | 17 |
| Propane, n-butane | | | 1.15 | 6 |
| 2. Propane, i-pentane | 6 | 5 | 1.25 | 17 |
| n-pentane, n-heptane | | | 1.15 | 1 |
| 3. Propane, i-pentane | 7 | 6 | 1.25 | 17 |
| n-butane, n-heptane | | | 1.27 | 5 |
| 4. Propane, n-pentane | 8 | 7 | 1.27 | 14 |
| n-butane, n-heptane | | | 1.27 | 5 |
| 5. Propane, n-pentane | 9 | 8 | 1.27 | 14 |
| ethane, n-butane | | | 1.40 | 4 |
| 6. Methane, propane | 10 | 9 | 1.95 | 15 |
| ethane, n-heptane | | | 1.77 | 3 |

* The lower of the two systems listed is the one which was used as the standard at all times. In other words, its vapor pressures were plotted as abscissae. The choice, as to which one to make the standard, was dictated at all times by the form in which the data were given in the original source.

$$R = \frac{T_{c_2}}{T_{c_1}}$$

$T_c$ = Critical Temperature
Sub 1 = More volatile component.

When the relative volatility of the system approaches that of the standard binary, the curvature in the critical region of the reduced pressure plot disappears. The criterion of relative volatility used was the ratio of the absolute critical temperature of the less volatile component to that of the more volatile component in the binary. When this ratio is the same for the system as for the standard binary, not only are all the lines of the reduced pressure plot straight, but they approach a slope of unity for all compositions.

## Method of Plotting

The steps of calculation and plotting are as follows:

1) Determine the critical temperature ratio of the components of the system and select as a reference binary system one whose ratio is as close as possible. Where more than one choice exists select that reference system whose components are closest in physical and chemical properties.

2) If necessary, cross-plot the total pressure data of the system so that values of total pressure are available as a function of temperature for the same liquid compositions as are given for the reference system.

3) From the critical temperature and pressure at each of the above compositions, calculate the reduced temperatures and pressures for the system.

4) For each of the above compositions, select the reduced pressures of the reference system at the same reduced temperatures from the calculations of step 3. A plot of reduced pressure against reduced temperature for the given liquid composition of the reference system will be necessary.

5) Plot on logarithmic paper from values on the Y axis the reduced total

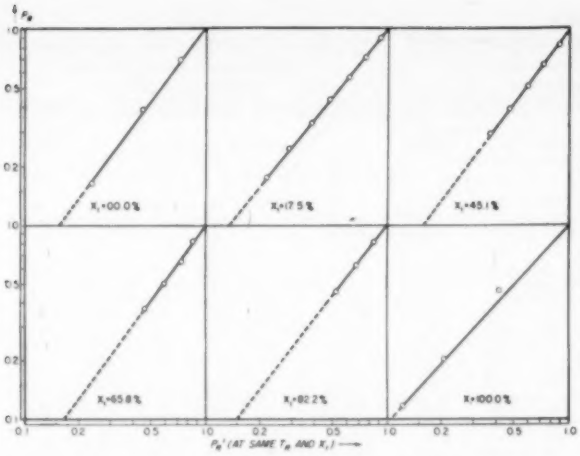


Figure 9. New reduced total pressure plot, Propane—n-Pentane against Ethane—n-Butane.

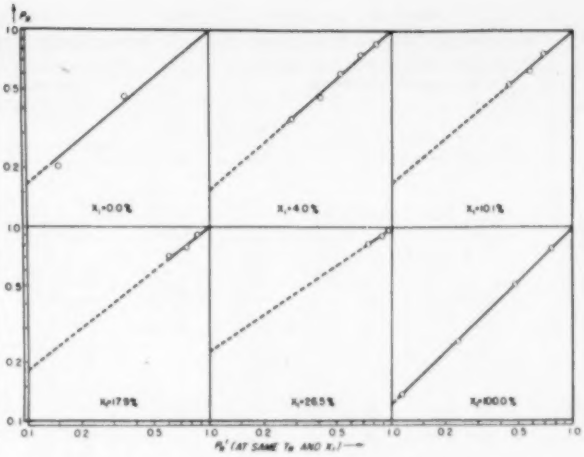


Figure 10. New reduced total pressure plot, Methane—Propane against Ethane—n-Heptane.

pressure of the system as obtained in step 3 against values on the X axis of the total reduced pressure of the reference system obtained in step 4. Straight lines will be obtained for the several liquid compositions; and these will all pass through the origin point, 1, 1, which represents the critical conditions.

### Systems Tested

For the purpose of testing the correlation, eight paraffin hydrocarbon binaries were chosen from the literature. These systems are listed in Table 3 which gives pertinent information about them, such as ratio of critical temperatures and sources of data. The data were presented in the original articles in either of two forms: Either as isotherms or as lines of constant composition. For systems that were reported in the form of constant composition lines, the data were simply converted into reduced temperatures and pressures. When reported as constant temperature lines, the data were cross-plotted to obtain lines of constant composition.

Six tests were made of the correlation as shown in Table 3. Final data employed in the plotting are given in Tables 4 to 9 inclusive, and the corresponding plots are given in Figures 5 to 10 inclusive. The two binaries for each test were chosen so that the critical temperature ratios were fairly close. The pressure-temperature curves at constant composition were determined for the same composition for both binaries, and the reduced vapor pressures of both were then plotted against each other at the same reduced temperature in a manner analogous to that used for single components. The calculations are apparent from the column headings in the tables.

In order to avoid confusion in the figures, instead of plotting as a sheaf of lines, each composition was plotted by itself. Since the slope of the lines appears to be very nearly the same for all compositions, plotting as a sheaf of lines would confound the points belonging to each composition, making it extremely difficult to interpret the data for each composition. The results in all cases show good

**TABLE 4**
**Calculation of Reduced Properties: Propane—i-Pentane Against Propane-n-Butane**

| PROPANE – i-PENTANE | | | | | Propane—n-Butane |
|---|---|---|---|---|---|
| $x_1$ $T_c$ $P_c$ | T °K | $T_R$ | P atm. | $P_R$ | $P'_R$ $P_R$ |
| 00.0% | | 0.714 | | 0.074 | 0.0900 |
| | | 0.805 | | 0.207 | 0.236 |
| | | 0.877 | | 0.400 | 0.450 |
| | | 0.948 | | 0.704 | 0.724 |
| 20.3% | 348 | 0.779 | 8.2 | 0.214 | 0.189 |
| 447 °K | 373 | 0.835 | 13.3 | 0.348 | 0.314 |
| 38.2 atm. | 398 | 0.890 | 20.0 | 0.524 | 0.499 |
| | 423 | 0.945 | 28.8 | 0.755 | 0.733 |
| | 433 | 0.969 | 32.9 | 0.861 | 0.854 |
| 35.1% | 348 | 0.795 | 11.5 | 0.280 | 0.228 |
| 437 °K | 373 | 0.853 | 18.0 | 0.437 | 0.386 |
| 41.1 atm. | 398 | 0.910 | 26.3 | 0.640 | 0.591 |
| 69.5% | 323 | 0.797 | 12.0 | 0.266 | 0.234 |
| 405 °K | 348 | 0.860 | 19.6 | 0.435 | 0.400 |
| 45.1 atm. | 373 | 0.921 | 30.0 | 0.665 | 0.628 |
| 81.7% | 323 | 0.825 | 13.7 | 0.304 | 0.286 |
| 392 °K | 348 | 0.888 | 22.7 | 0.505 | 0.480 |
| 45.0 atm. | 373 | 0.951 | 34.8 | 0.774 | 0.754 |

**TABLE 5**
**Calculation of Reduced Properties: Propane—i-Pentane Against n-Pentane-n-Heptane**

| PROPANE – i-PENTANE | | | | | n-Pentane n-Heptane |
|---|---|---|---|---|---|
| $x_1$ $T_c$ $P_c$ | T °K | $T_R$ | P atm. | $P_R$ | $P'_R$ $P_R$ |
| 0% | | 0.765 | | 0.1349 | 0.1093 |
| | | 0.895 | | 0.463 | 0.420 |
| | | 0.986 | | 0.917 | 0.906 |
| 25.5% | 373 | 0.841 | 14.7 | 0.374 | 0.307 |
| 444 °K | 398 | 0.897 | 22.3 | 0.567 | 0.486 |
| 39.3 atm. | 423 | 0.955 | 31.6 | 0.805 | 0.749 |
| | 433 | 0.975 | 35.8 | 0.911 | 0.810 |
| 55.8% | 348 | 0.831 | 16.2 | 0.366 | 0.296 |
| 419 °K | 373 | 0.891 | 25.0 | 0.565 | 0.485 |
| 44.2 atm. | 398 | 0.951 | 35.9 | 0.811 | 0.755 |
| 74.7% | 348 | 0.870 | 20.9 | 0.463 | 0.397 |
| 400 °K | 373 | 0.932 | 32.1 | 0.710 | 0.636 |
| 45.1 atm. | 398 | 0.995 | 44.9 | 0.994 | 0.978 |
| 100.0% | | 0.684 | | 0.0620 | 0.0450 |
| | | 0.738 | | 0.1182 | 0.0927 |
| | | 0.792 | | 0.205 | 0.1695 |
| | | 0.873 | | 0.460 | 0.369 |

**TABLE 6**
**Calculation of Reduced Properties: Propane—i-Pentane Against n-Butane—n-Heptane**

| PROPANE – i-PENTANE | | | | | n-Butane — n-Heptane |
|---|---|---|---|---|---|
| $x_1$ $T_c$ $P_c$ | T °K | $T_R$ | P atm. | $P_R$ | $P'_R$ $P_R$ |
| 00.0% | | 0.765 | | 0.135 | 0.109 |
| | | 0.830 | | 0.262 | 0.228 |
| | | 0.895 | | 0.463 | 0.420 |
| 15.9% | 323 | 0.718 | 4.3 | 0.115 | 0.120 |
| 450 °K | 348 | 0.773 | 7.3 | 0.196 | 0.191 |
| 37.3 atm. | 373 | 0.830 | 11.9 | 0.319 | 0.310 |
| | 398 | 0.885 | 18.2 | 0.488 | 0.473 |
| | 423 | 0.940 | 26.5 | 0.710 | 0.703 |
| | 433 | 0.961 | 30.5 | 0.818 | 0.801 |
| | 443 | 0.985 | 34.7 | 0.930 | 0.929 |
| 42.5% | 298 | 0.690 | 4.4 | 0.104 | 0.106 |
| 431 °K | 323 | 0.749 | 8.0 | 0.189 | 0.191 |
| 42.3 atm. | 348 | 0.806 | 13.0 | 0.307 | 0.311 |
| | 373 | 0.864 | 20.4 | 0.482 | 0.473 |
| | 398 | 0.923 | 29.5 | 0.698 | 0.691 |
| | 423 | 0.980 | 40.4 | 0.955 | 0.941 |
| 63.1% | 298 | 0.725 | 6.1 | 0.136 | 0.146 |
| 411 °K | 323 | 0.785 | 11.0 | 0.246 | 0.251 |
| 44.7 atm. | 348 | 0.845 | 18.0 | 0.402 | 0.407 |
| | 373 | 0.905 | 27.5 | 0.615 | 0.616 |
| | 398 | 0.966 | 40.0 | 0.895 | 0.876 |
| 80.1% | 273 | 0.693 | 3.8 | 0.084 | |
| 394 °K | 298 | 0.755 | 7.5 | 0.166 | 0.176 |
| 45.1 atm. | 323 | 0.820 | 13.4 | 0.296 | 0.311 |
| | 348 | 0.883 | 22.3 | 0.494 | 0.506 |
| | 373 | 0.946 | 34.2 | 0.757 | 0.766 |
| 94.1% | 273 | 0.723 | 4.5 | 0.104 | |
| 378 °K | 298 | 0.788 | 8.8 | 0.203 | 0.202 |
| 43.4 atm. | 323 | 0.855 | 15.8 | 0.364 | 0.352 |
| | 348 | 0.920 | 26.4 | 0.610 | 0.579 |
| | 373 | 0.986 | 40.5 | 0.935 | 0.911 |
| 100.0% | | 0.714 | | 0.093 | 0.090 |
| | | 0.873 | | 0.460 | 0.438 |

**TABLE 7**
**Calculation of Reduced Properties: Propane—n-Pentane Against n-Butane—n-Heptane**

| PROPANE—n-PENTANE | | | | | n-Butane — n-Heptane |
|---|---|---|---|---|---|
| $x_1$ $T_c$ $P_c$ | T °K | $T_R$ | P atm. | $P_R$ | $P'_R$ $P_R$ |
| 90.0% | | 0.857 | | 0.320 | 0.299 |
| | | 0.985 | | 0.881 | 0.900 |
| | | 0.931 | | 0.596 | 0.579 |
| 15.9% | 620 | 0.750 | 90 | 0.163 | 0.1525 |
| 827 °K | 650 | 0.785 | 127 | 0.230 | 0.212 |
| 551 atm. | 680 | 0.821 | 172 | 0.312 | 0.289 |
| | 710 | 0.859 | 229 | 0.415 | 0.392 |
| | 740 | 0.895 | 297 | 0.539 | 0.510 |
| | 770 | 0.930 | 377 | 0.584 | 0.539 |
| | 800 | 0.966 | 471 | 0.855 | 0.825 |
| 42.5% | 620 | 0.790 | 175 | 0.280 | 0.272 |
| 785 °K | 650 | 0.828 | 235 | 0.376 | 0.359 |
| 625 atm. | 680 | 0.866 | 306 | 0.490 | 0.480 |
| | 710 | 0.905 | 393 | 0.629 | 0.614 |
| | 740 | 0.942 | 492 | 0.788 | 0.772 |
| | 770 | 0.980 | 594 | 0.950 | 0.941 |
| 63.1% | 620 | 0.830 | 240 | 0.365 | 0.366 |
| 746 °K | 650 | 0.870 | 323 | 0.490 | 0.491 |
| 658 atm. | 680 | 0.911 | 419 | 0.635 | 0.639 |
| | 710 | 0.950 | 534 | 0.811 | 0.809 |
| | 740 | 0.991 | 643 | 0.977 | 0.983 |
| 80.1% | 620 | 0.870 | 298 | 0.446 | 0.461 |
| 713 °K | 650 | 0.911 | 408 | 0.610 | 0.608 |
| 668 atm. | 680 | 0.955 | 533 | 0.798 | 0.811 |
| 100.0% | | 0.714 | | 0.093 | 0.090 |
| | | 0.805 | | 0.246 | 0.236 |
| | | 0.873 | | 0.460 | 0.438 |

**TABLE 8**
**Calculation of Reduced Properties: Propane—n-Pentane Against Ethane—n-Butane**

| PROPANE—n-PENTANE | | | | | Ethane—n-Butane |
|---|---|---|---|---|---|
| $x_1$ $T_c$ $P_c$ | T °K | $T_R$ | P atm. | $P_R$ | $P'_R$ $P_R$ |
| 90.0% | | 0.714 | | 0.0676 | 0.0900 |
| | | 0.805 | | 0.1949 | 0.236 |
| | | 0.877 | | 0.381 | 0.450 |
| | | 0.948 | | 0.677 | 0.724 |
| 17.5% | 620 | 0.751 | 95 | 0.171 | 0.219 |
| 825 °K | 650 | 0.788 | 134 | 0.240 | 0.290 |
| 556 atm. | 680 | 0.825 | 180 | 0.324 | 0.384 |
| | 710 | 0.860 | 239 | 0.430 | 0.482 |
| | 740 | 0.897 | 308 | 0.554 | 0.607 |
| | 770 | 0.934 | 391 | 0.702 | 0.750 |
| | 800 | 0.970 | 487 | 0.875 | 0.913 |
| 45.1% | 620 | 0.795 | 182 | 0.289 | 0.373 |
| 780 °K | 650 | 0.833 | 244 | 0.388 | 0.475 |
| 630 atm. | 680 | 0.872 | 319 | 0.506 | 0.599 |
| | 710 | 0.910 | 408 | 0.648 | 0.726 |
| | 740 | 0.949 | 511 | 0.811 | 0.874 |
| 65.8% | 620 | 0.838 | 250 | 0.378 | 0.468 |
| 740 °K | 650 | 0.879 | 336 | 0.507 | 0.599 |
| 661 atm. | 680 | 0.920 | 435 | 0.657 | 0.746 |
| | 710 | 0.960 | 554 | 0.835 | 0.858 |
| 82.2% | 620 | 0.875 | 308 | 0.461 | 0.530 |
| 709 °K | 650 | 0.918 | 420 | 0.630 | 0.688 |
| 666 atm. | 680 | 0.960 | 548 | 0.821 | 0.858 |
| 100.0% | | 0.684 | | 0.0620 | 0.0661 |
| | | 0.738 | | 0.1182 | 0.1233 |
| | | 0.792 | | 0.205 | 0.210 |
| | | 0.873 | | 0.460 | 0.418 |

**TABLE 9**
**Calculation of Reduced Properties: Methane—Propane Against Ethane—n-Heptane**

| METHANE—PROPANE | | | | | Ethane—n-Heptane |
|---|---|---|---|---|---|
| $x_1$ $T_c$ $P_c$ | T °K | $T_R$ | P atm. | $P_R$ | $P'_R$ $P_R$ |
| 90.0% | | 0.684 | | 0.0620 | 0.— — |
| | | 0.738 | | 0.1182 | 0.0792 |
| | | 0.792 | | 0.205 | 0.1519 |
| | | 0.873 | | 0.460 | 0.350 |
| 4.1% | 293 | 0.795 | 16.1 | 0.352 | 0.288 |
| 368 °K | 313 | 0.850 | 20.9 | 0.456 | 0.409 |
| 45.8 atm. | 328 | 0.891 | 27.4 | 0.599 | 0.528 |
| | 343 | 0.932 | 33.9 | 0.741 | 0.684 |
| | 353 | 0.959 | 39.0 | 0.852 | 0.832 |
| 10.1% | 293 | 0.805 | 27.2 | 0.530 | 0.444 |
| 364 °K | 313 | 0.860 | 31.7 | 0.619 | 0.578 |
| 51.3 atm. | 328 | 0.900 | 38.8 | 0.756 | 0.691 |
| 17.9% | 293 | 0.820 | 40.8 | 0.700 | 0.610 |
| 357 °K | 313 | 0.876 | 45.5 | 0.780 | 0.761 |
| 58.4 atm. | 328 | 0.919 | 52.1 | 0.895 | 0.873 |
| 26.5% | 293 | 0.845 | 54.9 | 0.827 | 0.751 |
| 347 °K | 313 | 0.902 | 59.9 | 0.908 | 0.896 |
| 66.3 atm. | 328 | 0.945 | 65.9 | 0.993 | 0.993 |
| 100.0% | | 0.731 | | 0.1366 | 0.1136 |
| | | 0.805 | | 0.259 | 0.236 |
| | | 0.895 | | 0.513 | 0.485 |
| | | 0.960 | | 0.781 | 0.770 |

correlation. It is also observed that as the ratios of critical temperatures of the two systems under test approach each other, the slopes of the lines of constant composition approach unity.

One other test was made that is not included in this report because the data were too scanty; namely, the comparison of the methane-n-pentane system against the methane-n-butane system.[13] From the very limited data, the correlation was not too good; however, this was explained on the basis that the critical temperature ratios were not only much larger but also different by a larger margin than in the other cases, and that the sensitivity of the criterion of critical temperature ratio increases with the value of the ratio. It may be concluded from the plot, however, that were the ratios equal for each system, the correlation would be successful.

## Conclusions

A successful straight line correlation has been developed by logarithmic plotting at constant composition the values of reduced total pressures of one binary system versus corresponding values for another at the same reduced temperature.

The results of the above correlation naturally lead to the development of a generalized method for the prediction of total pressures of any paraffin binary system. This prediction would also require a means of determining the critical pressure and temperature as a function of composition of the binary from the individual components. Here again the principle of standardized systems of the same critical temperature ratio should be helpful. At present, work is being done to apply the above methods of correlation to a generalized method of prediction and the indications are hopeful that a successful method will materialize.

It follows that values of the total pressures of the two systems at the same reduced temperatures may be plotted at the same vapor compositions rather than at the same liquid compositions. Furthermore it may be readily shown that the entire method may be used equally well for multicomponent systems of three or any number of hydrocarbons. It may thus be used for any natural gas or petroleum crude or fraction, provided the critical conditions may be estimated and a key component established.

### NOMENCLATURE

P = Total Pressure

$R = \frac{Tc_2}{Tc_1}$

T = Absolute temperature

x = Mol Fraction in Liquid Phase

Subscripts

1 = More Volatile Component

2 = Less Volatile Component

C = Critical Condition

R = Reduced Temperature or Pressure

Superscripts

' = Refers to Standard System

### BIBLIOGRAPHY


[1] Cummings, L. W. T., Stones, F. W., and Volante, M. A., Ind. Eng. Chem., **25**, 728 (1933).
[2] Kay, W. B., Ibid., **28**, 1014 (1936).
[3] Kay, W. B., Ibid., **30**, 459 (1938).
[4] Kay, W. B., Ibid., **32**, 353 (1940).
[5] Kay, W. B., Ibid., **33**, 590 (1941).
[6] Nysewander, C. N., Sage, B. H., and Lacey, W. N., Ibid., **32**, 118 (1940).
[7] Othmer, D. F., Ibid., **32**, 841 (1940).
[8] Othmer, D. F., Ibid., **34**, 1072 (1942).
[9] Othmer, D. F., and Gilmont, R., Ibid., **40**, 2118 (1948).
[10] Othmer, D. F., and Gilmont, R., Ibid., **36**, 858 (1944).
[11] Othmer, D. F., and Gilmont, R., Petroleum Refiner, Nov., 1951, Vol. 30, pp. 111-118 and Jan., 1952, Vol. 31, pp. 107-116.
[12] Othmer, D. F., and Beattie, R. D., Ibid., April, 1952, Vol. 31, pp. 129.
[13] Sage, B. H., Hicks, B. L., and Lacey, W. N., Ind. Eng. Chem., **32**, 1085 (1940).
[14] Sage, B. H., and Lacey, W. N., Ibid., **32**, 992 (1940).
[15] Sage, B. H., Lacey, W. N., and Schaafsma, J. G., Ibid., **26**, 214 (1934).
[16] Sage, B. H., Reamer, H. H., Olds, R. H., and Lacey, W. N., Ibid., **34**, 1108 (1942).
[17] Vaughn, E. W., and Collins, F. C., Ibid., **34**, 885 (1942).


### ACKNOWLEDGMENT


Figures 1 to 4 in this article have been reproduced by permission of the editors of *Industrial and Engineering Chemistry* and of the copyright owners, the American Chemical Society.

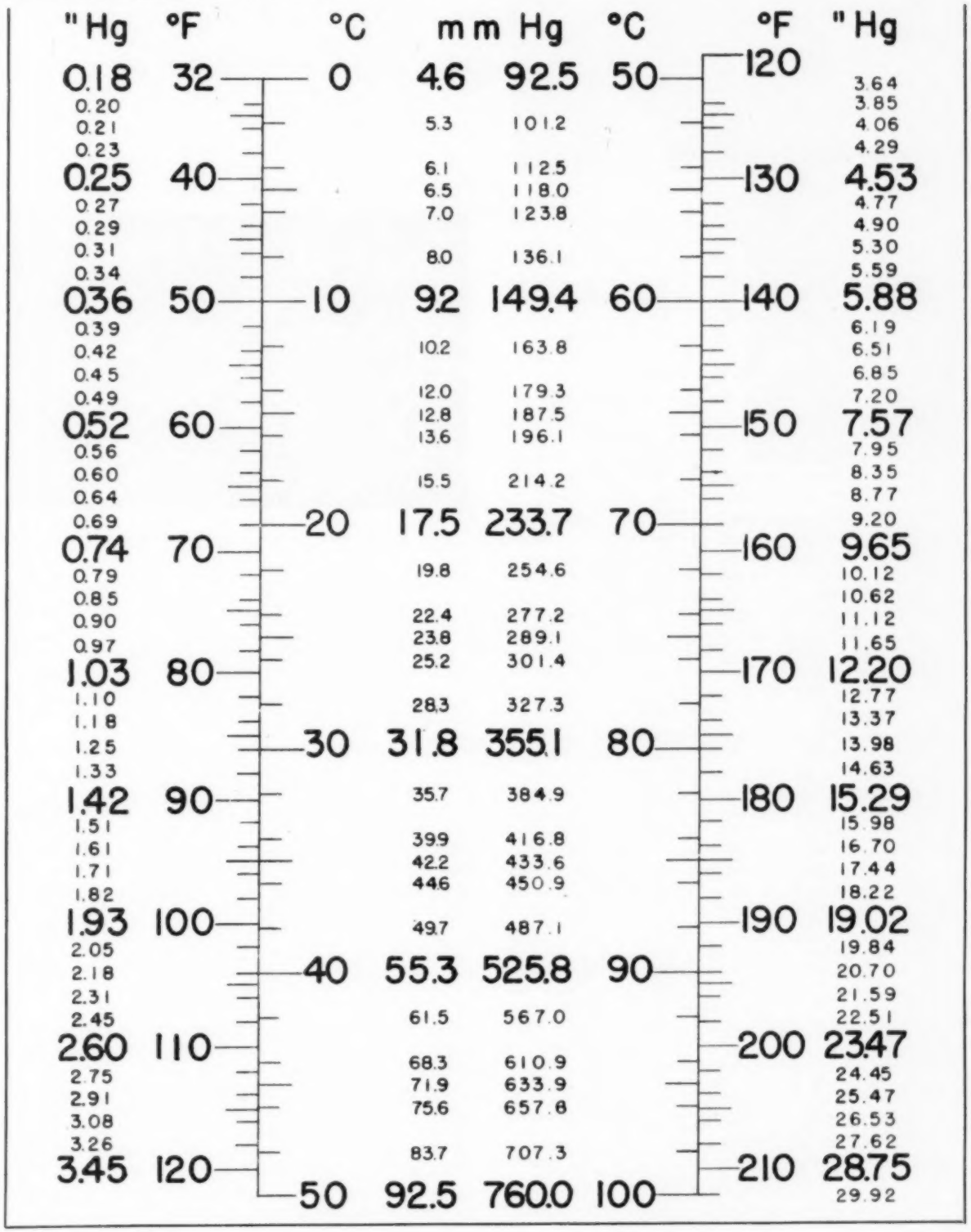

### FOOTNOTE

Previous articles in this series have appeared in Ind. Eng. Chem. during 1940, 1942, 1943, 1944, 1945, 1946, 1948, 1949, 1950, 1952 and 1953; in Chem. Met. Eng., 1940; in Chemie and Industrie (Paris), 1948; in Euclides (Madrid), 1948; in Sugar, 1948; and in Petroleum Refiner, 1951 and 1952.

# Vapor Pressure of Water and Temperature Conversion Chart

**Kenneth A. Kobe,** University of Texas, Austin

THIS timesaver can be used in several ways. You can immediately determine the vapor pressure of water in English or metric units at any temperature from freezing to boiling. You may also use chart to convert from Fahrenheit to Centigrade temperature scales.



*A Design Handbook . . . .*

# . . . Thermal Stresses in Piping Systems

## Part III

**William E. Wilbur,** The Fluor Corporation, Ltd., Los Angeles

THIS SERIES of articles is aimed at giving the design engineer a practical workable handbook of piping design methods. All of the methods and data presented have been tested by the author's company and found to be reliable. Parts I and II of the three-part series appeared in the March and April issues of PETROLEUM REFINER. This is the third and concluding section of the Handbook.

### 22. Three Plane Structures

When the pipe structure does not lie entirely in one plane, a complete analysis becomes very tedious, requiring approximately three times as much computation as a single plane structure. Before beginning such an analysis, therefore, it is desirable to make a rough calculation to determine whether the stresses are likely to be critical.

For such a preliminary study, Flex-Anal charts 35 and 36 are useful. The lines in each of the three main directions may be summed into one length in each direction, maintaining the correct distances between anchors. Application of the charts is then a simple procedure. It should be noted that these charts are based on square corners, so that the results will be merely approximate. Three-plane structures are, however, much more flexible than single-plane structures, and application of the charts will frequently indicate that the structure is safe, and thereby avoid the necessity for a complete analysis.

Sometimes the structure is predominantly in one plane, with only one or two short lines at right angles to it. It is then possible to get a fair approximation by reducing it to one plane; the members perpendicular to that plane appear as dots, and are considered to have a length equal to 1.3 times their actual length, as explained in the complete problem below. This method, of course, gives only two of the three reactions, and these will usually be greater than the true reactions. If the computed stresses from this procedure are safe, the line will not need to be further investigated.

When the structure is so complicated that neither of the above approximations is satisfactory, a complete analysis should be made. Spielvogel's book gives the method in detail for a complete and exact computation. It is, however, very time-consuming. The method outlined below eliminates a great deal of the detail figuring, and is close enough for practical purposes.

The procedure is as follows:

1) Draw an isometric view of the structure, showing the x, y and z directions.

2) Calculate separately the XY, XZ and YZ planes, according to the following rules:

a) Members appearing in their full length are treated exactly as for a single-plane structure.

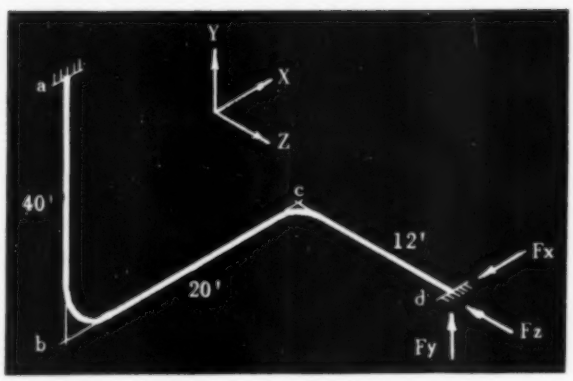



**Figure 24. Example of three-plane structure.**

b) Members at right-angles to the plane appear as dots, and are assumed to have lengths equal to 1.3 times their actual lengths.

c) The structure is treated as square-cornered, with an extra allowance being made for bends, as in Sec. II, only when the bend appears in its true length in the plane considered.

d) Due to the approximations used, the locations of the elastic center, determined from the separate planes, will not exactly agree.

3) The calculations for the separate planes have now given two values each for Ix, Iy and Iz. These are added together for the true values.

4) As in single-plane structures, signs of the quantities Ixy, Ixz and Iyz are of value only as showing the direction of slope of the thrust line. In inserting them in the equations below, they should be taken as positive.

5) Determine the reactions by solving simultaneously the following three equations:

$$FxIx - FyIxy - FzIxz = EeIX \quad (22\text{-}1)$$

$$-FxIxy + FyIy - FzIyz = EeIY \quad (22\text{-}2)$$

$$-FxIxz - FyIyz + FzIz = EeIZ \quad (22\text{-}3)$$

where X, Y and Z are the distances between anchors in the x, y and z directions, respectively, and Fx, Fy and Fz are the reactions in the same directions.

6) The work will be simplified, and smaller numbers used, if the quantity EeI, which appears in all the equations, is omitted in the solution, and inserted at the end of the calculations. The right-hand members of the equations are then merely X, Y and Z, respectively.

7) If the pipe is of several sizes, first divide each length by its corresponding I, as in Section 13, and omit the

quantity I in the right-hand members of Equations (22).

8) If there is movement of an anchor, make a supplementary calculation, substituting EIAx for EeIX, and similarly for the other planes, in the right-hand side of Equations (22). This is a simple operation, since the left-hand sides of the equations remain as before, and the solution has already been made; only the constant quantity is changed.

9) Further calculations to obtain the maximum stresses will be explained after the typical example below has been worked out. (See Figure 24, preceding page.)

Eight-inch Pipe Sch. 40; Max. Temp. 600 F.; Internal Press, 250 psi.; Ee = 103,300; I = 72.5.

**XY Plane—Origin at a.**

| Line | KL | x' | KLx' | y' | KLy' |
|---|---|---|---|---|---|
| ab | 40.0 | 0 | 0 | —20.0 | — 800 |
| b | 8.4 | 0 | 0 | —40.0 | — 336 |
| bc | 20.0 | +10.0 | +200 | —40.0 | — 800 |
| cd | 15.6 | +20.0 | +312 | —40.0 | — 624 |
| | 84.0 | + 6.1 | +512 | —30.5 | —2560 |

| Line | KL | x | Iy | y | Ix | Ixy |
|---|---|---|---|---|---|---|
| ab | 40.0 | — 6.1 | 1490 | 10.5 | 4400<br>5333 | —2570 |
| b | 8.4 | — 6.1 | 312 | — 9.5 | 760 | + 488 |
| bc | 20.0 | + 3.9 | 305<br>667 | — 9.5 | 1805 | — 741 |
| cd | 15.6 | +13.9 | 3010 | — 9.5 | 1410 | —2060 |
| | | | 5784 | | 13708 | —4883 |

**XZ Plane**

| Line | KL | x' | KLx' | z' | KLz' |
|---|---|---|---|---|---|
| ab | 52.0 | 0 | 0 | 0 | 0 |
| bc | 20.0 | +10.0 | +200 | 0 | 0 |
| c | 8.4 | +20.0 | +168 | 0 | 0 |
| cd | 12.0 | +20.0 | +240 | + 6.0 | +72 |
| | 92.4 | + 6.6 | +608 | + 0.8 | +72 |

| Line | KL | x | Iz | z | Ix | Ixz |
|---|---|---|---|---|---|---|
| ab | 52.0 | — 6.6 | 2269 | — 0.8 | 33 | + 275 |
| bc | 20.0 | + 3.4 | 231<br>667 | — 0.8 | 13 | — 54 |
| c | 8.4 | +13.4 | 1510 | — 0.8 | 5 | — 90 |
| cd | 12.0 | +13.4 | 2160 | + 5.2 | 325<br>144 | + 835 |
| | | | 6828 | | 520 | + 966 |

**YZ Plane**

| Line | KL | y' | KLy' | z' | KLz' |
|---|---|---|---|---|---|
| ab | 40.0 | —20.0 | — 800 | 0 | 0 |
| bc | 26.0 | —40.0 | —1040 | 0 | 0 |
| cd | 12.0 | —40.0 | — 480 | + 6.0 | +72 |
| | 78.0 | —29.7 | —2320 | + 0.9 | +72 |

| Line | KL | y | Iz | z | Iy | Iyz |
|---|---|---|---|---|---|---|
| ab | 40.0 | + 9.7 | 3750<br>5333 | — 0.9 | 32 | — 350 |
| bc | 26.0 | —10.3 | 2760 | — 0.9 | 21 | + 241 |
| cd | 12.0 | —10.3 | 1270 | + 5.1 | 311<br>144 | — 630 |
| | | | 13113 | | 508 | — 739 |

**Summary**

| Ix | Iy | Iz | Ixy | Ixz | Iyz |
|---|---|---|---|---|---|
| 13708 | 5784 | | 4883 | | |
| 520 | | 6828 | | 966 | |
| | 508 | 13113 | | | 739 |
| 14228 | 6292 | 19941 | 4883 | 966 | 739 |

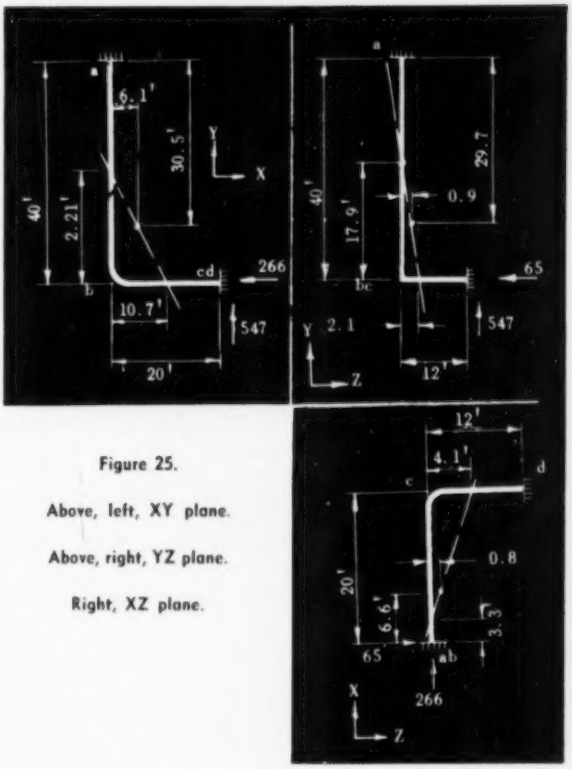



**Figure 25.**

**Above, left, XY plane.**

**Above, right, YZ plane.**

**Right, XZ plane.**

Solutions of Equations (Slide-rule calculations)

14228 Fx — 4883 Fy — 966 Fz = 20.00
— 4883 Fx + 6292 Fy — 739 Fz = 40.00
— 966 Fx — 739 Fy + 19941 Fz = 12.00

966 Fx — 332 Fy — 65.6 Fz = 1.36
— 966 Fx + 1248 Fy — 146.5 Fz = 7.94

+ 916 Fy — 212.0 Fz = + 9.30
— 1071 Fy + 19875.0 Fz = + 13.36

+ 1071 Fy — 248.0 Fz = + 10.90

+ 19627.0 Fz = + 24.26

Fz = .00124

+ 1071 Fy = + 10.90 + 0.31 = + 11.21

Fy = .01050

966 Fx = 1.36 + 3.48 + 0.08 = 4.92

Fx = .00510

These must be multiplied by
Ee I/144 = 103300 x 72.5 / 144 = 52000
giving finally
Fx = 266 lbs. Fy = 547 lbs. Fz = 65 lbs.

In Figure 25, the structure is shown projected in the three separate planes, with the thrust lines located.

The points of greatest stress are those farthest from the thrust lines. It may be necessary to try several points to find the true maximum. For this example, the stresses at point c will be determined.

In the XY plane, there is a torsion in one leg of the fitting, or a moment in the other leg, of $547 \times 9.3 = 5100$ ft. lbs.

In the XZ plane, there is a moment of $266 \times 4.1 = 1090$ ft. lbs. (In the plane where the fitting appears in its true length, the stress can be moment only.)

In the YZ plane, the torsion in one leg, or moment in the other, is $547 \times 2.1 = 1150$ ft. lbs.

For maximum moment, combine XY and XZ plane effects, according to the formula

$$M = \sqrt{M^2_{xy} + M^2_{xz}} = \sqrt{(5100)^2 + (1090)^2} = 5215 \text{ ft. lbs.}$$

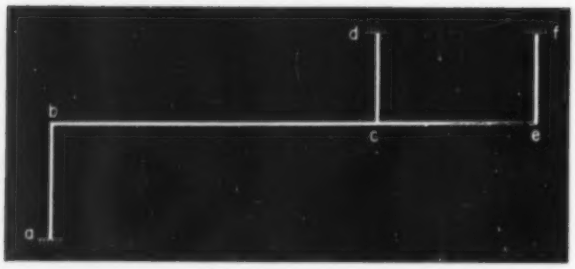



Figure 26. See "Multiple Anchors" below.

The unit stress $f_m$ due to this moment is $M/Q = 5215 \times 12 / 7.29 = 8600$ psi. The value of Q is taken from Table 3.

The unit stress $f_t$ due to torsion is $T / 2$ S.M. $= 1150 \times 12/2 \times 16.8 = 410$ psi. The value of S.M. is taken from Table 2.

The unit longitudinal stress $f_p$ due to internal pressure is (Table 5) $595 \times 2.5 = 1490$ psi.

The unit circumferential stress $f_c$ due to internal pressure is $2\ f_p = 2980$ psi.

The maximum stress is then determined from the formula:

$$f = \tfrac{1}{2}\ (f_m + f_p + f_c + \sqrt{(2f_t)^2 + (f_m - f_p)^2}\ )$$

whence $f = \tfrac{1}{2}\ (8600 + 1490 + 2980 + \sqrt{(820)^2 + (7110)^2}\ ) = 10114$ psi.

Since this is well below the allowable, the stress at point c is satisfactory.

Other points may be similarly analyzed. In all cases, moments in two planes are combined to find $f_m$, and the torsion in the third plane gives $f_t$.

The expression $\sqrt{A^2 + B^2}$, which appears in the two above formulas, is readily solved by slide-rule, thus:

Let $\sqrt{A^2 + B^2} = A + C$. Then $C = \dfrac{B^2}{2A + C}$. For an approximate value of C, figure $\dfrac{B^2}{2A}$. Make this correction to the denominator, and refigure C.

From the example above: Find $\sqrt{(5100)^2 + (1090)^2}$

Trial $C = 1090 \times 1090 / 2 \times 5100 = 117$

$C = 1090 \times 1090 / (2 \times 5100) + 117 = 115.$

Then $\sqrt{(5100)^2 + (1090)^2} = 5100 + 115 = 5215.$

When $f_t$ is relatively small, as in the example above, a sufficiently accurate formula is

$$f = f_m + f_p + \frac{f_t^2}{f_m - f_p}$$

$f = 8600 + 1490 + (410)^2 / 7110 = 10090 + 24 = 10114$

## 23. Multiple Anchors

The general method of analysis provides for only two anchors for a pipe structure. Occasionally, however, a system will have three or more anchors; for instance, where two or more pieces of equipment connect to a common header.

A complete mathematical analysis of such problems is possible by the method given in Kellogg's book (See Section 2); time limitations will generally prevent its use. An article by Boris Lochak, in the Transactions of the ASME for May, 1944, page 311, simplifies the problem for a three anchor structure in three planes; the time required is approximately three times that for a two-anchor structure.

The following approximations are suggested (See Figure 26):

1) If one of the lines, say cd, is of much smaller pipe than the other, ef, then the line cd may be omitted in the calculations.
2) Three separate analyses may be made: systems abcef, abcd, and dcef. Each line and anchor has now been used twice; each reaction will be approximately the sum of the two results found. Special consideration should be given to the loop dcef; these loops are frequently very stiff and cause high stresses.

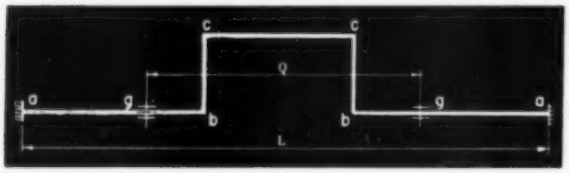



Figure 27.

## 24. Guides for Expansion Loops

The ordinary expansion loop (Figure 27) is subject to vertical movement at points b and in the upper tangent cc. As noted in Section 21, these movements may amount to several times the theoretical expansion of the length L.

To reduce these movements, guides are introduced at points g (and, if desired, at additional points between g and a). It is assumed that at the guides this deflection is reduced to zero, but that the pipe is still free to rotate slightly in the plane of the loop.

A complete mathematical analysis shows that the introduction of the guides increases the thrust, and the stresses in the loop bccb. This problem is discussed in Flex-Anal Charts, Part I, where the following procedure is suggested:

1) Figure the loop for the length Q, between points g, as if anchored at those points.

2) Multiply the thrust and maximum unit stress thus obtained by the ratio L/Q.

A comparison of this procedure with the mathematical solution indicates that the Flex-Anal method will generally show the maximum unit stress approximately correct, but slightly on the safe side; the computed thrust will be somewhat too large.

Use of guides will generally reduce the deflections at b and c to satisfactory amounts. Points g should be at least 15 to 20 feet from points b.

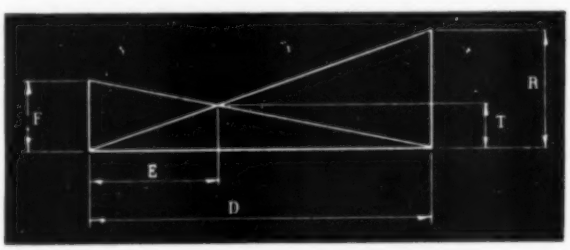



Figure 28.

## 25. Yielding Anchors

Occasionally, an anchor must be considered which is not rigid, but may yield as a result of the load (e.g., an anchor at the top of a single steel bent). In this case, the true condition may be determined by a simple diagram, Figure 28.

F = computed thrust of line against anchor.
D = Expansion of line in direction of anchor, if unrestrained.
R = force required to move anchor through a distance D.

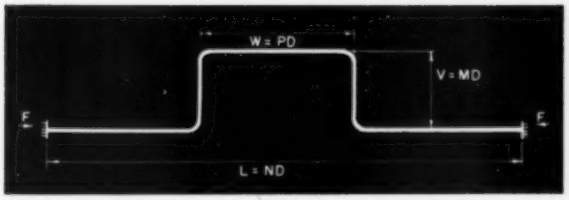
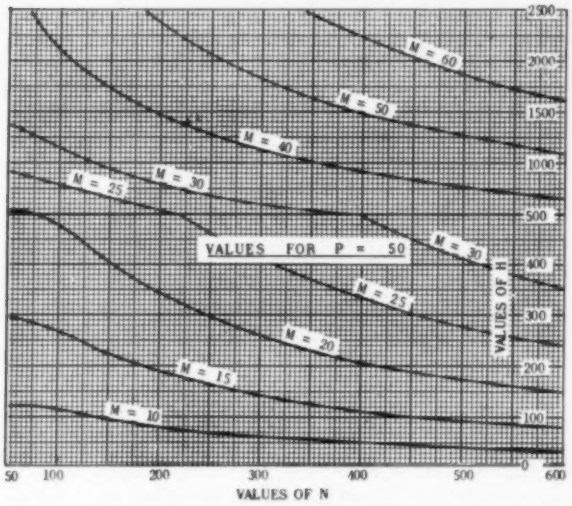



Figure 29. See "Expansion Loops Using Welding Elbows," below.



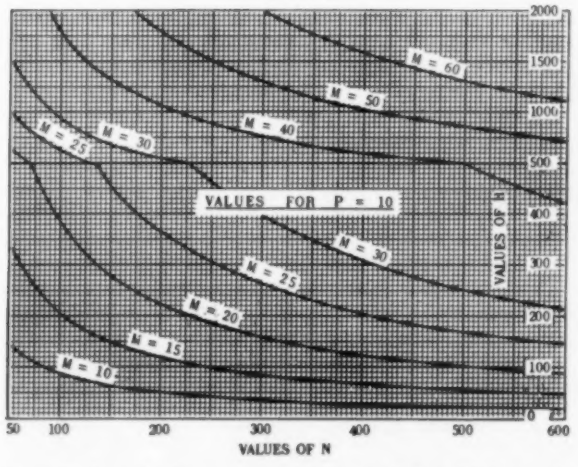




Figure 30. Expansion loops using welded fittings. Values of H in formula for Thrust — $F = \frac{EeG}{H}$ (lbs.). Values for intermediate values of P may be directly interpolated.

E = true deflection of anchor point $= \frac{FD}{R + F}$

T = true thrust at anchor point $= \frac{FR}{R + F}$

## 26. Expansion Loops Using Welding Elbows

This type of loop is discussed in Section 12. Properties of welding elbows are given in Table 3. The following approximate diagrams are based on these assumptions:

1) The loop is symmetrical about a vertical center line.

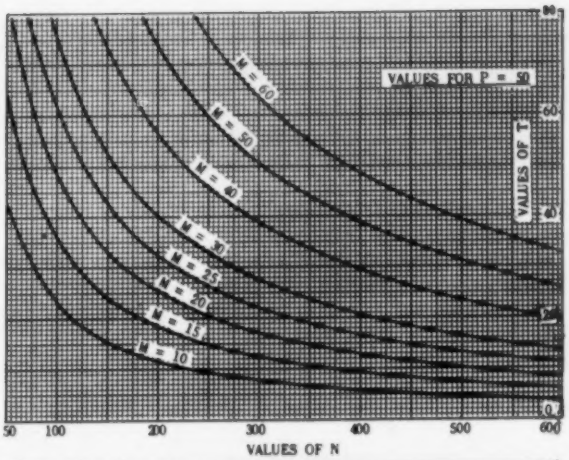
2) The effect of an elbow in increasing flexibility is approximated by the addition of an equivalent length of pipe at each elbow. This equivalent length is taken as 12 times the nominal diameter of pipe.

3) The maximum stress occurs in the elbows at the top of the loop. The formulas take account of the greater intensity of stress in an elbow as compared with straight pipe.

All lengths are computed as multiples of the nominal diameter of pipe, D.

Then the thrust $F = \frac{Ee\,G}{H}$

The maximum unit stress $f = \frac{Ee\,J}{T}$



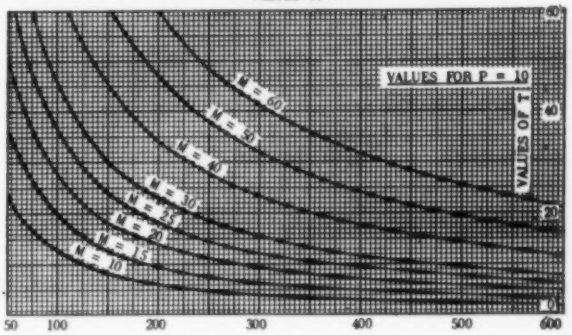




Figure 31. Expansion loops using welded fittings—Values of T in the formula for maximum unit stress $f = \frac{Ee\,J}{T}$ (psi).

**TABLE 6**

**Values of G and J for Standard 90° Bends**

$G = \frac{31}{D^2}$ $\qquad$ $J = \frac{31}{QD}$

D Nominal diameter, inches.
I Moment of Inertia, inches.
Q Equivalent Section Modulus, Table 3.

**Values for Standard-Weight Elbows:**

| D | t | G | J Short Rad. | J Long Rad. |
|---|---|---|---|---|
| 2 | .154 | 0.50 | 3.70 | 2.78 |
| 3 | .216 | 1.01 | 3.78 | 2.80 |
| 4 | .237 | 1.36 | 3.99 | 3.06 |
| 6 | .280 | 2.34 | 4.40 | 3.54 |
| 8 | .322 | 3.40 | 4.49 | 3.72 |
| 10 | .365 | 4.82 | 4.62 | 3.94 |
| 12 | .375 | 5.82 | 4.78 | 4.18 |
| 14 | .375 | 5.71 | 4.55 | 4.02 |
| 16 | .375 | 6.59 | 4.70 | 4.25 |
| 18 | .375 | 7.47 | 4.80 | 4.42 |
| 20 | .375 | 8.35 | 4.87 | 4.57 |
| 24 | .375 | 10.12 | 4.98 | 4.76 |

Figure 32. See "Vertical Deflection of Loop" in adjoining column.

Ee depends on the temperature. Values are obtained from Figure 3 or Table 1.

Constants G and J depend on the dimensions of the elbows. Values for standard fittings are given in Table 6.

Constants H and T depend on the dimensions of the loop. Values are obtained from the accompanying diagrams Figures 30 and 31. These diagrams give values for P = 10 and for P = 50. Intermediate values may be directly interpolated. For points which lie outside of the diagrams, the general formulas for H and T are given below.

The diagram values of F and f may be reduced by cold-springing. See Section 17.

### Formulas Used in Preparing Figures 30 and 31

For cases which do not fall within the limits of the diagrams, the following formulas may be used:

$$H = \frac{Z\,M^2}{N\,(N + 2M + 4A)}$$

$$T = \frac{Z\,M}{N\,(N + M + 2A - P)}$$

$$Z = \left( M(M + 2N + 8A) + 6A(2A + N) + 3P(N - P) \right)$$

N, M and P are the length ratios shown in Figure 29.

AD is the equivalent added length to account for the flexibility of each fitting; it is the quantity (LK-2R) in Table 3. In constructing the diagrams, the value of A was taken as 12.

The above formulas are general, and will give correct results for any symmetrical expansion bend of this type.

### Vertical Deflection of Loop

(See Figure 32)

Let dL = expansion of line between points "a" = eND.
Let db = upward deflection of points b, if not restrained.

$$\frac{db}{dL} = \frac{(N - P)^2\,(M + 2A + P)}{8M\,(AN + PN + \tfrac{1}{2}MN - P^2)}$$

*End of Part III and series.*

## Dr. Murphree Receives Institute's Award

Eger V. Murphree, president of Standard Oil Development Company, last month at White Sulphur Springs, W. Va., received the Industrial Research Institute's 1953 Medal.

Dr. H. N. Stephens, past president of the Institute and director of research, Minnesota Mining and Manufacturing Company, quoted Dr. Murphree's citation as follows: "skillful and inspiring leadership of an industrial group which made contributions of vital importance to our nation at war and peace and for (his) soundness of technical judgment and broadness of horizon which served well not only his firm but his country."

The Industrial Research Institute Medal has been awarded annually since 1945 to honor "outstanding accomplishment in leadership in or management of industrial research which contributes broadly to the development of industry or the public welfare."

In accepting the award, Dr. Murphree spoke on the subject of "Our Most Important Form of Energy," stating this as "the intellectual energy of man." In developing this theme, Dr. Murphree discussed the availability of fossil fuels such as oil, natural gas and coal. "We have heard a great deal in recent years about the danger of our running out of our fossil fuels," he said, ". . . (but) these discussions entirely rule out the consideration of what to me is our most important form of energy—that is the intellectual energy of man . . ."

Dr. Murphree touched briefly on the many sources of energy other than oil, and concluded, "Our effectiveness in utilizing these huge amounts of various forms of energy will depend basically on two factors—an incentive for so doing, and . . . the success of research. Both of these factors in turn depend on our intellectual energy . . ."

Dr. Eger V. Murphree, president of the Standard Oil Development Company (center) receives the Industrial Research Institute's 1953 Medal at the Institute's 15th annual meeting at White Sulphur Springs, W. Va., from Dr. H. N. Stephens, left, vice president of the Institute and Director of Research, Minnesota Mining and Manufacturing Company. Dr. Fred Olsen, president of the Institute and vice president, Research and Development, Olin Industries, Inc., looks on, at the right.

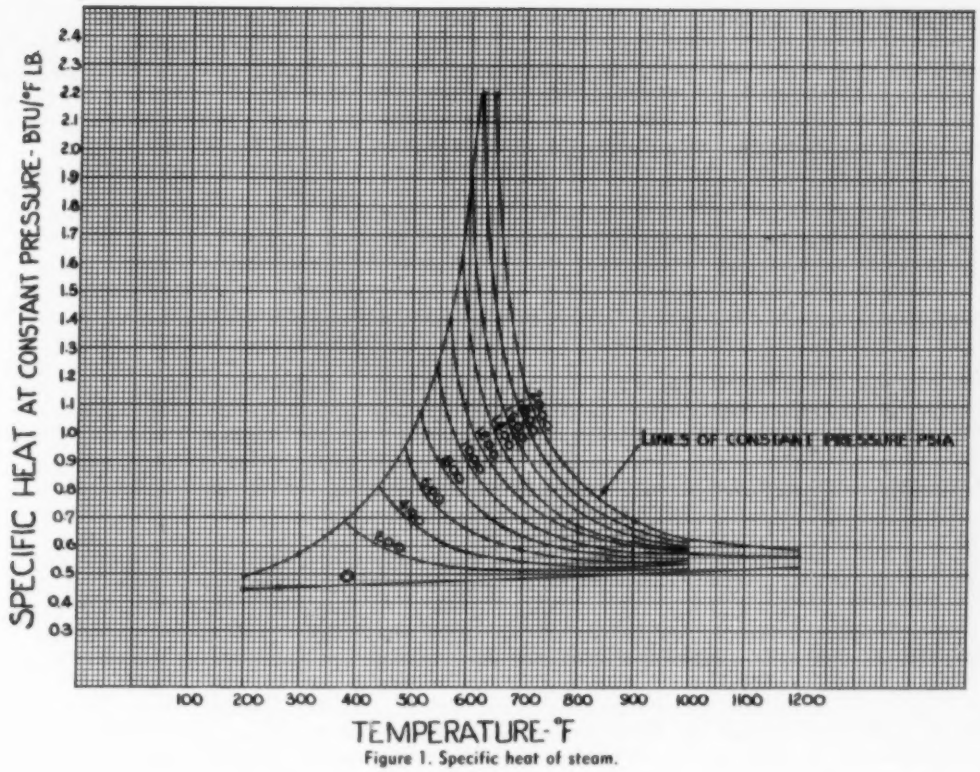


Figure 1. Specific heat of steam.

# Viscosity, Thermal Conductivity and Specific Heat Of Steam at Elevated Pressures and Temperatures

**Irving Granet and Philip Kass**
Foster Wheeler Corporation
New York

IN ORDER TO make accurate heat and mass balances, accurate data on the thermodynamic properties are necessary. Because of the wide use of steam, research on its properties has been done throughout the world. Under the sponsorship of the American Society of Mechanical Engineers, extensive work was done in this country at M. I. T. and the results were incorporated into the "Thermodynamic Properties of Steam."[1] commonly called the "Steam Tables." The degree of permanence of these tables can be seen from the fact that they appeared in 1936 and while many printings have appeared, no second edition has been published. Figure 1 from these tables has been plotted (over what the writers believe to be the most useful range) showing the instantaneous specific heat at constant pressure as a function of both pressure and temperature.

While the main body of the above mentioned Steam Tables has not been changed (Tables 1-5), Tables 6 and 7 for the viscosity and thermal conductivity have been changed for almost each printing. In 1950 Keyes and Sandell[2] published the results of their work on the thermal conductivity of steam. Their apparatus and methods were carefully checked and it is believed that the data presented in this paper represents the most accurate values available to date. These data have also been incorporated in the NBS-NACA tables as Table 4.42.[3] Unfortunately, when these data were incorporated into the steam tables, several of the reported values were incorrect. The table given by Granet and Gould[4] in their discussion of the Keyes and Sandell work, was calculated on a computing machine to seven places even though only four places were reported. Figure 2 shows the thermal conductivity as a function of pressure and temperature. This curve is based upon the above mentioned discussion by Granet and Gould.

The appearance of the Keyes and Sandell paper, while clarifying the situation on the thermal conductivity, has caused further confusion with regard to the viscosity of steam. Hawkins

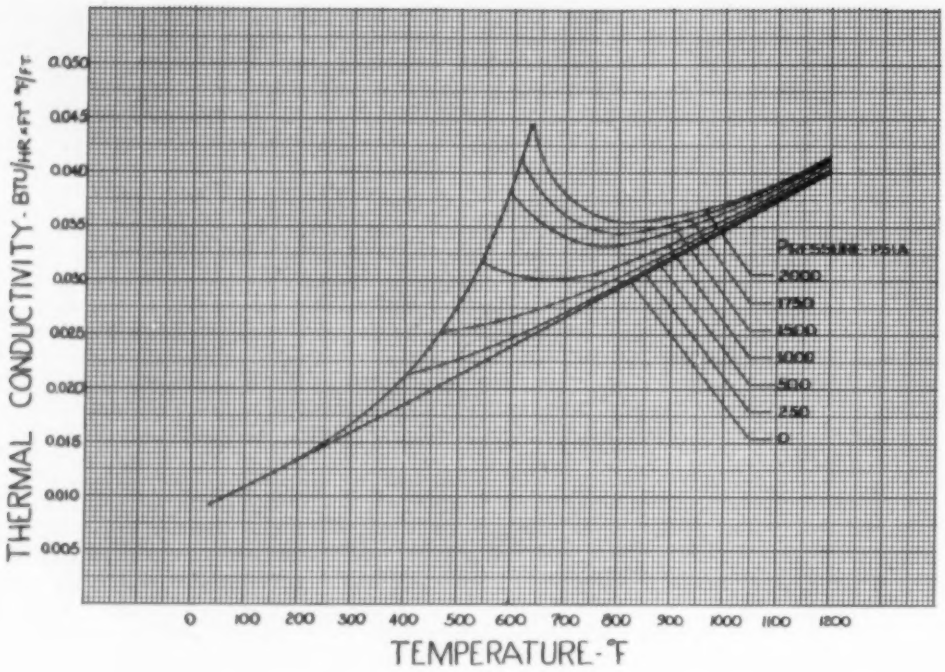



Figure 2. Thermal conductivity of steam based on calculations of Granet & Gould.

and co-workers at Purdue had published several papers on the viscosity of steam.[5,6] Vargaftig[7] and Timroth and Vargaftig[8] reported the results of their work on both the viscosity and thermal conductivity of steam. Figures 3 and 4 show the viscosity of steam as a function of pressure and temperature as determined by the Russian and Purdue investigators. The data plotted in Figure 4 are based upon the correlation of Hawkins work by Leib.[9]

As will be noted from these curves there is a great discrepancy between these investigators. The Purdue data shows a marked dependance upon pressure not apparent in the Russian results. In 1948, Hawkins[10] reviewed this situation and concluded that further work would be necessary before this discrepancy could be resolved. In the interim he suggested that either set of data could be used at the discretion of the user. Prior to the appearance of the new thermal conductivity values, the Steam Tables had first used the early Hawkins data and then the Russian data for viscosity. At the 1949 ASME annual meeting, one of the writers had occasion to speak to Professor Keyes regarding his paper and the situation then existant with regards to the viscosity. Professor Keyes stated at that time that in view of the new data for the thermal conductivity of steam he felt that Leib's

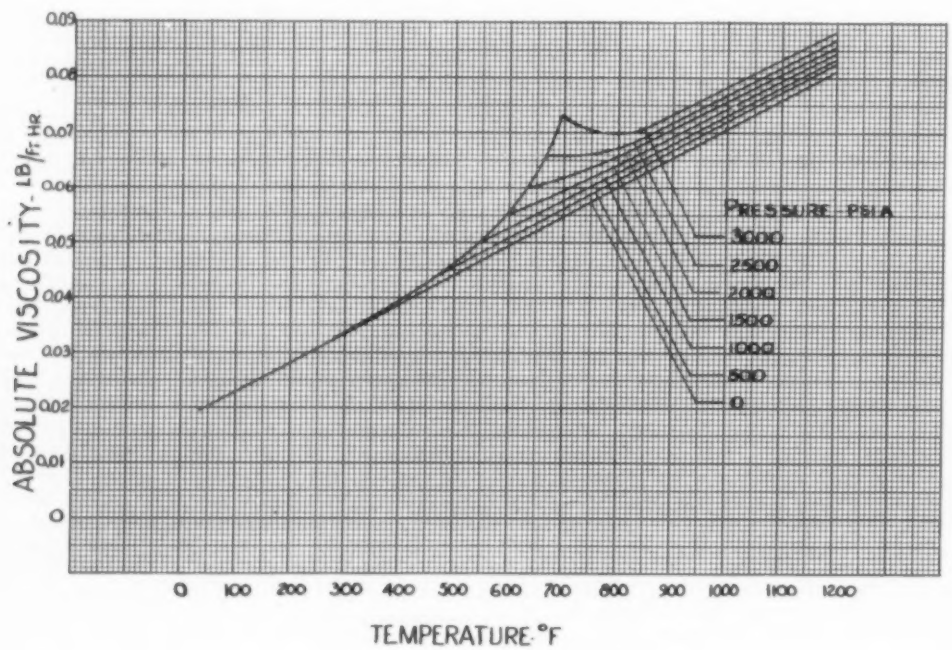



Figure 3. Viscosity of steam based upon data of Timroth.

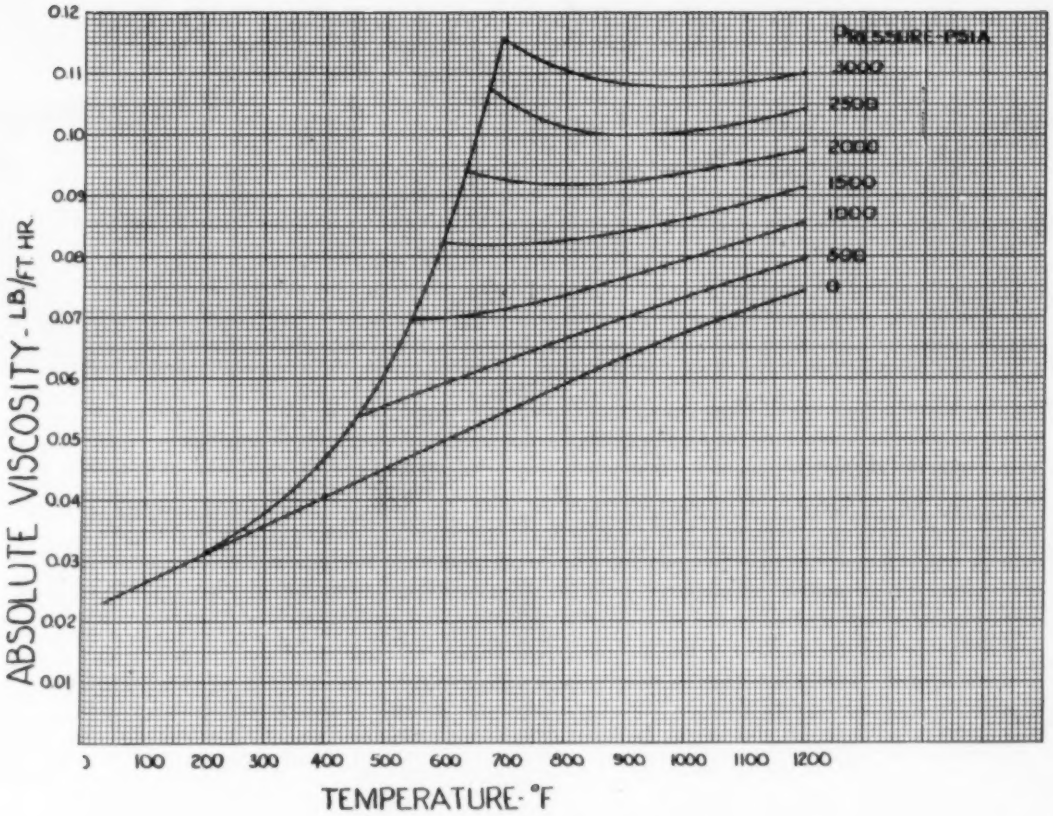



Figure 4. Viscosity of steam based upon Leib correlation.

correlation of the Purdue work was probably the more nearly correct determination of the viscosity of steam. In support of this view, the latest printings of the Steam Tables have reported Leib's correlation.

The writers feel, however, that the best data available for the viscosity of steam are shown in Figure 3. The reasons are given below. It is certainly necessary to redetermine this property and the writers are awaiting the further tests that Professor Hawkins[10] noted were to be undertaken at Purdue University.

Based upon the work of Enskog,[11] qualitatively, at elevated pressures, the thermal conductivity should first decrease exhibiting a minimum point and then increase with increasing temperature. Certainly the peculiar curvature shown for the zero pressure and 500 psia curves of Figure 4 does not even come near this rule while the Russian data qualitatively follows exactly. Secondly, the very great dependence on pressure shown in Figure 4, varies considerably from the behavior of the viscosity of nearly every other gas or vapor the writers are familiar with. The third reason that the writers have for recommending the Russian data is indirect and based upon heat transfer data. Using the Colburn correlation[12] for forced convection heat transfer the writers plotted the film coefficient h as a function of

$$\frac{K^{0.6}\, cp^{0.4}}{\mu^{0.4}}$$

against temperature for various pressures. The values of thermal conductivity (K) were from Keyes and Sandell and the viscosity ($\mu$) was taken from both the Purdue and Russian data. The Russian data gave a relatively smooth function in this correlation, while the Purdue data gave a very unusual set of curves which the writers have yet to be able to explain.

## References


[1] "Thermodynamic Properties of Steam" by J. H. Keenan and F. G. Keyes, John Wiley and Sons, 1936.

[2] "New Measurements of the Heat Conductivity of Steam and Nitrogen" by F. G. Keyes and D. J. Sandell, Trans. ASME, Aug. 1950, Vol. 72, No. 6, pp767-775.

[3] The NBS-NACA Tables of Thermal Properties of Gases—Table 4.42; Steam-Thermal Conductivity, Compiled by R. L. Nuttall, Dec. 1950.

[4] Discussion to Reference (2) by I. Granet and R. M. Gould. This discussion follows the Keyes and Sandell paper in the volume listed in Reference 2.

[5] "The Viscosity of Water and Superheated Steam" by G. A. Hawkins, H. L. Solberg, and A. A. Potter, Trans. ASME, Vol. 57, 1935, pp395-400.

[6] "The Viscosity of Superheated Steam" by G. A. Hawkins, H. L. Solberg, and A. A. Potter, Trans. ASME, Vol. 62, pp677, 1940.

[7] "The Dependence of the Coefficients of Thermoconductivity of Gases and Vapors on the Pressure," by N. Vargaftig, Tech. Phys. (USSR), Vol. 4, 1937, p343.

[8] "Thermal Thermoconductivity and Viscosity of Steam at High Temperatures and Pressures" by D. L. Timroth and N. Vargaftig, Journal of Physics (USSR), Vol. 2, 1940, pp101-111.

[9] E. F. Leib, "Combustion", Vol. 12, p45, 1940.

[10] "Review of Data on Dynamic Viscosity of Water and Superheated Steam," by G. A. Hawkins, W. L. Sibbitt and H. L. Solberg, Trans. ASME Vol. 70, 1948, pp19-23.

[11] Enskog, D., Kunglia Svenska Vetenskapsakademiens Handligar, 63, No. 4 (1922).

[12] "Heat Transmission" by W. H. McAdams, 2nd. Edition, 1942, McGraw Hill Book Co., p168.


**NOTE**

Previous articles by the same authors have been used in recent issues of PETROLEUM REFINER as follows:

Dry air, October, 1952;

Carbon dioxide, November, 1952;

Nitrogen, February.

# [ MEET OUR AUTHORS ]

Lewis F. Hatch | F. G. Wilson | Aksel C. Eld | Ted Weaver | F. E. Mathews

## Popular Texas Author Feels Youth Misspent

**Lewis F. Hatch,** "Petroleum as a Raw Material for the Chemical Industry, page 143.

This well known member of The University of Texas faculty has developed quite a following throughout Texas and the U. S. As associate director, Combustion Kinetics Project (acetylenic compounds), research chemist (fuels), Defense Research Laboratory, and professor of chemistry at Texas, he has influenced the thinking of many of his students as well as students in many other schools.

Born in Puyallup, Wash., he squandered his youth "playing with the Indians and the berry pickers (female)." His educational background includes a B.S. degree in chemistry, State College of Washington; a M.S. degree, Purdue University, 1934; and a Ph.D. degree, Purdue University, 1937. Before joining the University of Texas faculty he was a research chemist at Shell Development Company for three years.

During World War II he organized numerous courses in chemistry for personnel in the petroleum industry under a wartime training program. For the last 13 years he has taught what may be today—and surely was for years—the only petrochemicals course in the country. He has authored over 40 papers and holds eight patents on petrochemicals. He belongs to several technical organizations and is listed in *American Men of Science, Who's Who in Education* and *Who Knows and What.*

## API "Fireman" Has Impressive Service List

**Franklin G. Wilson,** "Industry Should Boast of Great Fire Record," page 209.

This energetic and versatile director of API Safety and Fire Protection Services was born in Chicago. He received most of his formal education in Alabama, supplementing it with special courses at Carnegie Tech of Pittsburgh and American University of Washington, D. C.

His petroleum industry career began in 1927, when he joined Gulf Oil Corporation's engineering department at Port Arthur, Texas. After 15 years with Gulf, followed by important service with the Construction and Refining division of PAW, he joined Cities Service Refining Corporation at Lake Charles, La., as chief draftsman. He subsequently returned to Washington as a petroleum engineer for the Air Transport Command, and in 1945 he joined API as assistant director of the Department of Safety.

Wilson became director of API Safety and Fire Protection Service in 1950. His work has included: secretary, Central Committee on Accident Prevention and Central Committee on Fire Protection of the Institute; API representative on the National Fire Protection Association Flammable Liquids Committee; alternate for API representative on Committee on Protection against Lightning, and various other NFPA committees; alternate for API to a number of American Standards Association committees; secretary to the National Safety Council, Petroleum Section; and a member of the American Society of Safety Engineers.

Schaafsma | Klinkert | Hoog

## Humanics Exponent Has Diversified Experience

**F. E. Mathews,** "Let Supervisors Participate," page 217.

This superintendent of the Industrial Relations division at the Casper, Wyo., refinery of Standard Oil Company (Indiana) is a strong exponent of the art of Humanics in industrial relations.

Mathews has had diversified experience, beginning with his student days at the University of Nebraska, where he studied business administration. After a short stretch with Swift and Company, he joined the Casper refinery as an accounting department clerk. He was named storekeeper in 1929 and was advanced to the head of industrial relations work in 1945.

## Designer Relaxes by Shooting And Digging

**Aksel C. Eld,** "A New Approach to Tray Design," Page 157.

Aksel C. Eld came to the U. S. in 1923 from Odense, Denmark, where he was born and received his diploma in mechanical engineering at the Technical Institute. His first jobs were with Westinghouse Electric & Manufacturing Company and Mesta Machine Company.

He joined Gulf Oil Corporation at Port Arthur, Texas, as a designer in 1927. Since about 1930 he has been in process engineering work, specializing in fractionating tower design.

A professional chemical engineer licensed by Pennsylvania, Eld is married and has two children. When not occupied as a designer, he relaxes by workinging out new developments in his hobbies, photography and gardening.

## Dutch Trio Writes on New Process Features

**H. Hoog, H. G. Klinkert and Albert Schaafsma,** "New Shell Hydrodesulfurization Process Shows These Features," page 137.

These three Dutch scientists are associated with the Royal Dutch Shell Group: Hoog with Koninklijke-Shell Laboratorium; Klinkert and Schaafsma with Bataafsche Petroleum Maatschappij. All are located in Amsterdam, The Netherlands.

Amsterdam born Hoog was graduated in 1934 by Delft Technical University with a degree in chemical engineering. He joined Bataafsche immediately thereafter as a research chemist in the Amsterdam laboratories. He received his doctor's degree from Delft in 1940. Following World War II he was placed in charge of the catalytic research section of the laboratories, later advancing to head of the process-development and pilot-plant section. For the past two years, Hoog has been associated director of process research and development.

Klinkert was born in Rotterdam and was graduated by Delft with an engineering degree in 1942. He then joined MEKOG, a Royal Dutch Shell group company, as a plant technologist. In 1945 he was transferred to Bataafsche's

# Don't Forget to SPECIFY REVERE

## CONDENSER TUBES AND PLATES

Year after year users of condenser tubes and plates specify Revere, not only for new equipment, but when re-tubing. You might consider this fact if you are not as yet a Revere customer.

Correct specification is vitally important, because conditions vary so greatly. Each installation presents an individual combination of factors, each one of which should be studied before deciding on the proper alloy. It is often advisable to make a new survey of the situation before re-tubing, because the nature of the cooling water may have changed, or other service alterations have taken place.

To find the alloy or combination of alloys best suited to meet a specific set of circumstances, Revere offers the help of its Research Department, made available through the Technical Advisory Service. Working with the country's leading users of condensers and heat exchangers, these capable consultants have helped solve many and varied types of problems, leading to longer tube life.

Revere makes tubes and tube sheets in all the customary alloys. See the nearest Sales Office.

**REVERE**

**COPPER AND BRASS INCORPORATED**

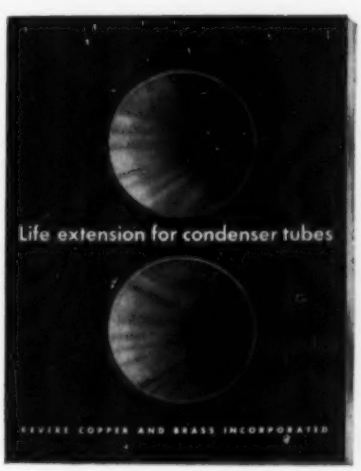
*Founded by Paul Revere in 1801*

230 Park Avenue, New York 17, N. Y.

*Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N.Y. Sales Offices in Principal Cities, Distributors Everywhere.*

**SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS**

This 28-page booklet is of unusual interest in these times when it is more important than ever to squeeze every last day of use out of condenser and heat exchanger tubes. It includes data on various copper alloys, photos of different types of condenser tube corrosion, and photomicrographs of the grain structure of different metals under varying operating conditions. Write on your firm's letterhead for your free copy. Ask for "Life Extension for Condenser Tubes."



# [ Meet Our Authors ]

R. J. Fiorentino | A. M. Hall | Henry D. Noll | Jack C. Dart | T. A. Burtis

head office at The Hague, where he took part in the development of various chemical and oil conversion processes.

Schaafsma obtained his scientific education at Groningen University in The Netherlands. Being trained as a physicist, he took special interest in the fields of rontgen and molecular spectra, and, in 1932, he received his doctor's degree for his thesis, "On the Spectrum of Barium-Hydride." he joined the Royal Dutch Shell group in 1933 as research physicist at the Amsterdam laboratories. Since 1952 he has been in charge of the lubricating-oil process section of the organization's development department.

## Battelle Metallurgists Check Graphitization

**Robert J. Fiorentino and A. M. Hall,** "How Serious Is Graphitization?", page 132.

New York born Fiorentino was graduated by Rensselaer Polytechnic Institute in 1952 with a B.S. degree in metallurgical engineering. Since July, 1952, he has been associated with Battelle Memorial Institute, Columbus, Ohio, as a research engineer. He is currently engaged in graduate study towards a master's degree in metallurgy at Ohio State University.

Hall joined Battelle as a research engineer in 1945, going there after eight years with International Nickel Company. In 1947 he became assistant supervisor of metallurgical research at Battelle. He was graduated with an A.B. degree in 1935, a B.S. degree in 1936, and a Met.E. degree in 1936 by Columbia University's School of Mines. He is the author of papers and technical articles on nickel and alloys, graphite formation in steel, metallography and photomicrography, recrystallization, and corrosion of metals at high temperatures.

## Process Engineer Totals Acetylene Cost

**Theodore Weaver,** "What Acetylene Costs," page 151.

Theodore Weaver is a principal process engineer with The Fluor Corporation, Ltd., with which he has been associated since 1944. Since he joined the organization, his work has included process design of oil refining units in fields of cracking and heavy oils distillation, as well as natural gasoline, cycling, pressure maintenance and petrochemical operations.

After being graduated from California Institute of Technology with an M.S. degree in chemical engineering in 1941, he joined Tide Water Associated Oil Company. From then until he joined Fluor he was engaged in the process and mechanical design of various refining units.

## Houdry Trio All Had Magnolia Stint

**Henry D. Noll, Jack C. Dart and Theodore A. Burtis,** "How Feed Stock and Severity Affect Houdriforming Economics," page 113.

Henry Noll, like his co-authors, is with Houdry Process Corporation, Philadelphia. He has been associated with the company since 1944 and was recently appointed director of engineering. He studied at the University of Boulder, Colo., later attending the graduate school at the University of Pittsburgh, where he received a degree in petroleum engineering. Following three years with Standard Oil Company of New York, he transferred to Magnolia Petroleum Company, Beaumont. In nine years with Magnolia he was concerned with all phases of development work. In 1938 he joined the research and development laboratories of Socony-Vacuum Oil Company, Inc., where he was placed in charge of both thermal and catalytic cracking.

Jack Dart, with Houdry since 1947, is now manager of research and development. Prior to joing Houdry he held various engineering positions with Standard Oil Development Company, Magnolia Petroleum Company and Pan American Refining Corporation. He received his B.S. and M.S. degrees from the University of Michigan, Ann Arbor.

Theodore Burtis also joined Houdry in 1947 and was recently appointed supervisor of process engineering. Before going to Houdry he was employed in an engineering capacity by Magnolia Petroleum Company and Owens-Fiberglas Company. He has served as chief of the economics section of Houdry's research and development division and as director of development. He was graduated from Carnegie Institute of Technology, Pittsburgh, and received his M.S. degree from Texas A & M College.

## Writing Foursome Joins Forces on TPC Process

**Howard W. Shea, Kenneth E. Magin, Louis P. Evans and Joseph I. Savoca,** "TPC Process Offers These Advantages," page 117.

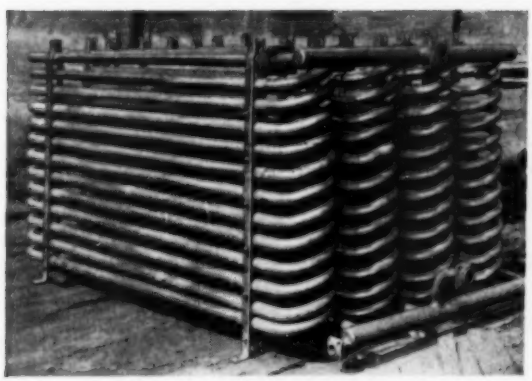
Shea, Magin, Evans and Savoca: a writing quartet from Socony-Vacuum Research and Development Laboratories, Paulsboro, N. J. Shea, in addition to his work on a moving-bed process for refining lubricating oils, has been concerned with the engineering and process development of Socony's moving-bed pyrolytic cracking (TPC),

Louis P. Evans | Howard W. Shea | Kenneth E. Magin | Joseph I. Savoca | R. P. Northup

IN 5 MODERN FABRICATING SHOPS

# CRANE

# builds pipe coils to DESIGN perfection



2-in. ammonia cooling coils with welded headers and ammonia flanges.

You get the results you planned for in pipe coils built by Crane. And right along with this close adherence to specification goes a greater dependability that enhances your design.

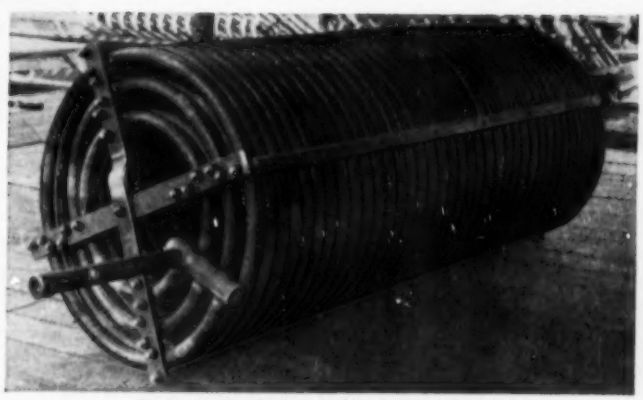
Although seamless carbon steel pipe is most popular, Crane has the experience—and the equipment to produce pipe coils in wrought iron, copper, brass, nickel, aluminum, 18-8 of various types, and miscellaneous alloys. At your service are the finest facilities for heat-treating, stress-relieving and testing of all kinds. Crane can also supply those necessary piping accessories to give your design the added value of consistent quality throughout.

There's further information on this important Crane service in your Crane No. 53 Catalog—and in the 48-page Pipe Coil Handbook, offered below.

## FREE 48-PAGE PIPE COIL HANDBOOK

### Gives Valuable Design and Specification Data

Dimensions, materials, and connections, pipe data, helpful engineering information—you'll find it all in this factual, easy-to-read handbook, free to pipe coil designers and users. Drop a card to Crane at the address below for your copy (Circular 318).



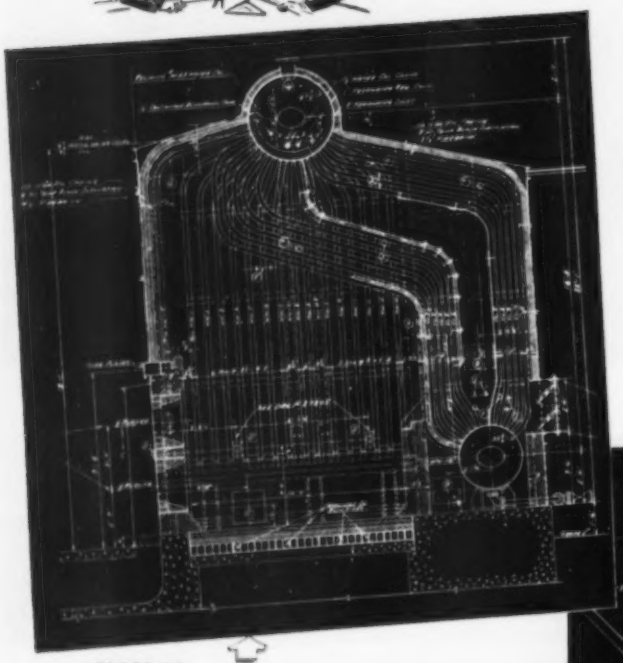
Triple circular design of 1½-in. seamless pipe.

# CRANE CO.

*General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
*Branches and Wholesalers Serving All Industrial Areas*

**VALVES • FITTINGS • PIPE • PLUMBING • HEATING**

# Industry Approved

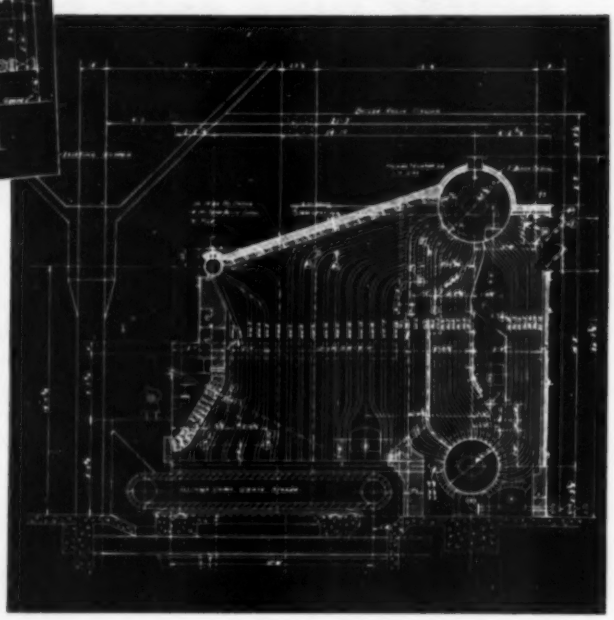


## *Two-Drum*

## STEAM GENERATORS

## by Vogt

**CLASS VF**
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



**CLASS VS**
The Seelbach Hotel, Louisville, Ky. is served by this 50,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

*A bulletin with general information and showing typical installations is available on request.*

## Typical Users...

**FOOD PROCESSING PLANTS**

**DISTILLERIES • HOTELS**

**HOSPITALS • CHEMICAL PLANTS**

**PETROLEUM REFINERIES**

**HENRY VOGT MACHINE CO., Louisville 10, Kentucky**

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

# Meet Our Authors

D. F. Othmer | T. R. Roszkowski | Roger Gilmont | Frank H. Walker | Wm. J. O'Meara

catalytic cracking (TCC), and catalytic reforming (TCR) processes. Magin, a chemical engineer in the process development section, has been concerned with the development of moving-bed catalytic and reforming processes, as well as with the refining of lubricating oils. Evans is supervisor of the process development section at the Socony laboratories. Savoca, a research chemical engineer, has also been engaged in research on catalytic cracking and on the refining of lubricating oils.

Shea was graduated from Texas A. & M. College in 1941. He spent five years in the Army, serving in the European theater. He has been in the process development section of the Socony laboratories since 1946.

While studying at the University of Pennsylvania, Magin was called into the service, serving three years in the Signal Corps. He joined the Socony laboratories in 1946 and continued his studies at Drexel Institute of Technology, being graduated in 1950.

Evans received his B. S. degree in chemical engineering from Massachusetts Institute of Technology in 1931. Following five years on various petroleum research projects at The Texas Company's Beacon, N. Y., laboratories, he joined the research staff of Socony-Vacuum Oil Company, Inc. During his service with Socony he has been associated with the development of many important refining processes now in use in the petroleum industry, and he has received numerous patents in the field of petroleum refining. His activities have included various trips to Europe, the latest as a member of a government commission to obtain technical information on German processes.

Savoca received his degree in chemistry from Brooklyn College in 1941. After serving four years in the Air Force, he continued his studies at the University of Tulsa, receiving his M.S. in petroleum engineering in 1948. That same year he joined Socony laboratories.

## Two From Atlantic Write Lube Paper

**Frank H. Walker, Jr., and William J. O'Meara,** "Are You Lubricating Your Motors Properly," page 127.

These co-authors are both with The Atlantic Refining Company, Philadelphia. Walker, with the company since April, 1952, is supervisor of electrical engineering in the engineering and construction department. O'Meara, with Atlantic since 1946, is a member of the engineering research division of the same department, concerned with special electrical problems in marine, pipe line and refinery work.

Walker was graduated from the University of Rhode Island in 1939, with a degree in electrical engineering. He has been employed in various engineering positions by United States Rubber Company, Western Electric Company and Esso Standard Oil Company.

O'Meara attended Carroll College, Helena, Mont., and has extensive training and experience with General Electric Company, where he started in its testing and experimental laboratories. He later became G-E's assistant district engineer in Philadelphia.

## New Face Added to Familiar Writing Team

**Roger Gilmont, Donald F. Othmer and Theodore Roszkowski,** "New Correlations for Total Pressure of Binary Systems," page 167.

Neither strangers to each other nor to PETROLEUM REFINER are two of this three-man writing team. Dr. Gilmont and Dr. Othmer pooled their efforts in "Correlating Physical and Thermodynamic Properties Used in Petroleum Technology," which appeared in this publication in November 1951.

In no less than 12 "Who's Who" type books, including *Who's Who in America*, Othmer's myriad activities make an impressive list. This much traveled chemical engineer has been employed in Canada, Sweden, Spain, France, England, Belgium, Switzerland and in numerous other countries. Seemingly indefatigable, he has been called upon for consultation and service by most military departments of the U. S. government as well as various other civil branches. He holds over 75 U. S. and foreign patents on methods, processes and engineering equipment. Contributor of over 150 articles to technical journals and inventor, he has nevertheless found time to make extensive lecture tours since 1948.

Dr. Othmer obtained his M.S. and Ph.D. degrees at the University of Michigan. He joined the faculty of Polytechnic Institute of Brooklyn in 1932, advancing to head of the department of chemical engineering in 1937. He is a licensed chemical engineer in four States.

Quite successful himself when it comes to outstanding accomplishments, Dr. Gilmont won many scholastic honors in mathematics, physics and chemical engineering during his school days. Born in New York in 1916, he was awarded a M.S. degree in chemical engineering in 1943 from Polytechnic Institute of Brooklyn. Four years later he received his Ph.D. degree.

Since 1947 he has been technical director in charge of the Technical and Engineering department at Emil Greiner Company in New York. Concurrent with his duties at Emil Greiner Company he has been adjunct professor of chemical engineering, teaching courses in thermodynamics, at Polytechnic Institute since 1949.

Newcomer to the writing trio is Theodore R. Roszkowski, who is presently associated with Lummus Company's process department. A New Yorker, he completed his undergraduate work at the College of the City of New York in 1944, following which he served two years in the services. Discharged as a second lieutenant, navigator and radar operator, he began his graduate work at Brooklyn Polytechnic. After receiving a M.Ch.E. degree in 1947, he spent one year as an instructor in qualitative and quantitative analysis at Stevens Institute of Technology. The next three years he was an instructor in chemistry, physics and mathematics at the United States Merchant Marine Academy. In 1951 he joined Lummus in his present position.

## Author Knows Subject From Long Acquaintance

**R. P. Northup,** "Explosion Proof Equipment is Here to Stay," page 123.

Presently vice president of Crouse-Hinds Company, Syracuse, R. P. Northup joined his company in 1935 as a sales engineer. The following year he was transferred to the Houston office, where he was associated with the development of explosion proof electrical equipment in use in refineries.

In 1942 he was appointed field engineer in the general sales department of Crouse-Hinds at Syracuse. During this time his duties were concerned with the application and design of explosion proof equipment for all types of wartime plants. He was appointed general sales manager in 1947, advancing to commercial vice president in 1951.

# Cut cost and corrosion in the process

## WITH ALCOA ALUMINUM FOR PROCESS EQUIPMENT

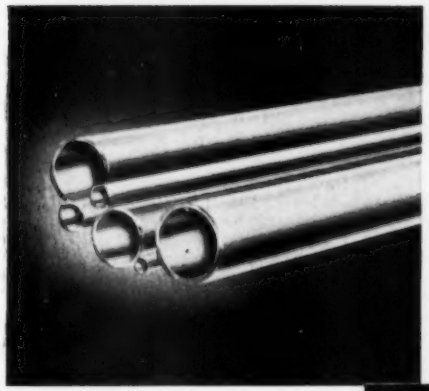
Alcoa Aluminum offers many advantages to the process industries—generally at lower original cost than other corrosion-resistant metals. For example, Alcoa Aluminum offers:

**EXCELLENT LOW-TEMPERATURE PROPERTIES.** Aluminum actually increases in strength and ductility as temperatures drop to −320° F and below. Alloy 3S-H14, for example, improves 67 per cent in tensile strength, 23 per cent in yield strength and more than 80 per cent in elongation.

**LOW COST.** Aluminum continues to have a significant price advantage over most other metals. For example, Alcoa Heat Exchanger Tubes cost 1/3 less than mild steel, 1/2 less than Admiralty, 1/5 as much as stainless.

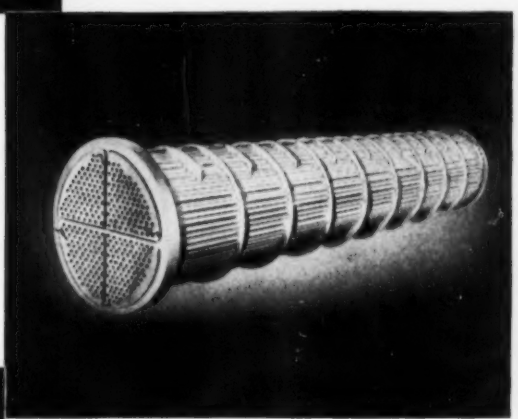
**HIGH RESISTANCE TO CORROSION.** Aluminum effectively withstands the corrosive effects of hydrogen sulphide and other sulphur compounds, most waters, carbon dioxide and many other organic and inorganic chemicals, food, drug and petroleum products.

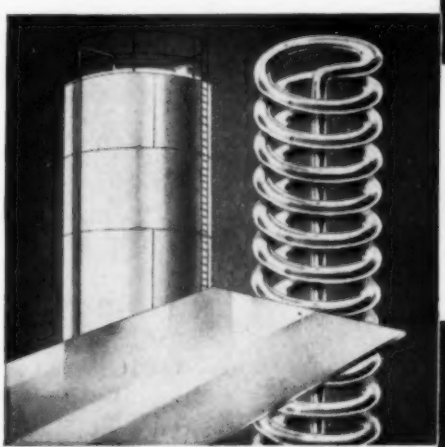
**GOOD WORKABILITY.** Aluminum is easy to form, shape, machine and assemble with standard equipment. It can be joined by all the common methods of welding. Certain alloys can be brazed.



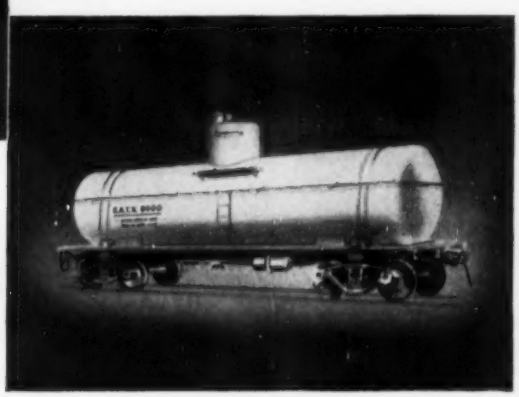
**ALCOA ALUMINUM PIPE** is the lowest cost corrosion-resistant metal pipe. It is not attacked by, nor does it contaminate or discolor, many chemicals. Does not cause sludge or gum in petroleum products. Friendly to most foods, beverages, oils. Alcoa Pipe is ideal for railings, scaffolds, storage racks and many other structural uses. Write for the booklet: "Alcoa Aluminum Pipe."

**ALCOA ALUMINUM HEAT EXCHANGER TUBES** offer *big* savings in original cost. For instance, an average-sized refinery can save $50,000 in first cost (figured on 20,000 tubes) over other metal tubes. Further savings in handling, shipping, cleaning—as well as excellent low temperature service and resistance to corrosion—make Alcoa Tubes the best buy, by far, for heat exchanger service. Write for the booklet: "Alcoa Aluminum Heat Exchanger Tubes."





**ALCOA ALUMINUM SHEET AND PLATE,** Forgings, Coiled Tube, Tread Plate and Storage Tanks offer exceptional cost-cutting advantages to the processing field. Write for the pamphlet: "Alcoa Aluminum in the Process Industries."



**ALCOA ALUMINUM TANK CARS.** Shippers everywhere report: No damage to ladings . . . no damage to cars, when valuable liquids are delivered in Alcoa Aluminum Tank Cars. Talk to your car builder, or write to Alcoa.

ALUMINUM COMPANY OF AMERICA
905-E Alcoa Building, Pittsburgh 19, Pa.

**For process chemicals —catalysts, catalyst carriers and desiccants —investigate ALCOA Chemicals.**

**Alcoa Aluminum**

**ALUMINUM COMPANY OF AMERICA**

## [ NEW BOOKS ]

### *Refinery Wastes*

**Waste Water Containing Oil, Fifth Edition,** Division of Refining, American Petroleum Institute, 50 W. 50th Street, New York 20. $2.

The Fifth Edition of Volume I of the *API Manual on Disposal of Refinery Wastes* is another step in the oil industry's continuing program to protect water resources adjacent to petroleum refineries. It was prepared by the Division of Refining of the American Petroleum Institute.

The manual is a five-volume affair designed to provide refiners with technical information to assist them in preventing the escape of noxious or harmful materials beyond plant fences.

Volume I, *Waste Water Containing Oil,* deals with the collection and treatment of waste water so that it will not contaminate adjacent rivers and streams when it is released. The last edition was published in August, 1949.

New information in the Fifth Edition includes the latest design data for gravity-type oil-water separators. This information is based on three years of research and experimentation at the University of Wisconsin under Professor G. A. Rohlich.

Volume I was prepared for the use of executives in resolving questions of expenditures for disposal equipment; for the use of refinery managers in deciding questions of refinery equipment and operation; for the use of engineers in designing disposal equipment; and for the use of supervisors in overseeing the operation and maintenance of disposal equipment and in instructing men who operate the equipment and facilities.

### Timely Synthetic Products Data

**The Science of Petroleum, Volume V, Part II. Synthetic Products of Petroleum,** Dr. B. T. Brooks and Dr. A. E. Dunstan, Oxford University Press, New York. $35.

In 1938 the Oxford University Press undertook the complex and urgently needed compilation of scientific data on the science and technology of petroleum. With the publishing of the four main volumes of *The Science of Petroleum* in that year, information previously found only in scattered journals and half-forgotten records was brought together in a compact, authoritative treatise covering almost every aspect of the prospecting, production, refining and transportation of mineral oil and natural gas.

But, because of far-reaching technical advances made since their publication, the volumes have become lacking in timeliness, and supplementary volumes have become necessary. However, much of the material in the original four volumes is of permanent value.

Volume V, of which this book is the second part, deals with the chemistry, physics and chemical engineering of petroleum. Part I was published in 1950. The editors hope to close this section of the subject in due course with a third and final part. This will be followed by Volume VI in four parts.

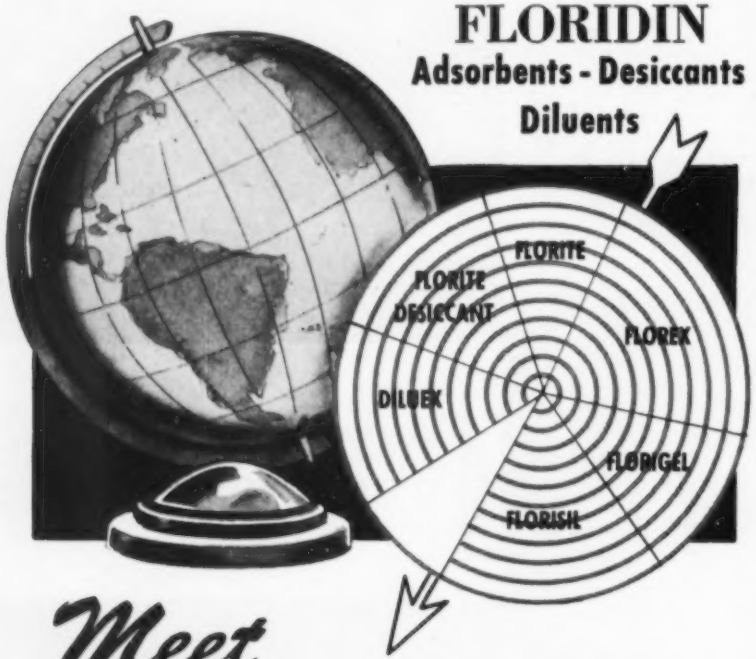
Volume V, Part II, covers the synthetic products of petroleum, including raw materials for rubber solvents, and considers intermediate refinery processes. The section devoted to refinery processes is subdivided into distillation, refinery processes, cracking, hydrogenation and dehydrogenation, dewaxing and alkylation.

### Synthetic Lubricants

**Present Problems and Future Trends in Lubrication,** U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C. $0.75.

A guide for chemists to new products needed in the field of lubrication and how to achieve them is provided in this new Naval Research Laboratory report. It points out that since World War II the need for operating machines at new extremes of speed, temperature and altitude has resulted in a tremendous development of new synthetic lubricants. The major advances in synthetic lubricants made in recent years are taken up one by one. The new problems and further development opportunities created by each advance are discussed. Each discussion cites the basic references on that advance.

The advances are discussed under these major subject headings: Research on Friction and Wear Prevention; The Molecular Structure Required in a Synthetic Oil; Synthetic Oils, Present and Future; Anti-oxidants; Rust Inhibitors; Viscosity Index Improvers; Detergency in Oils; Lubricating Greases; and General Trends.

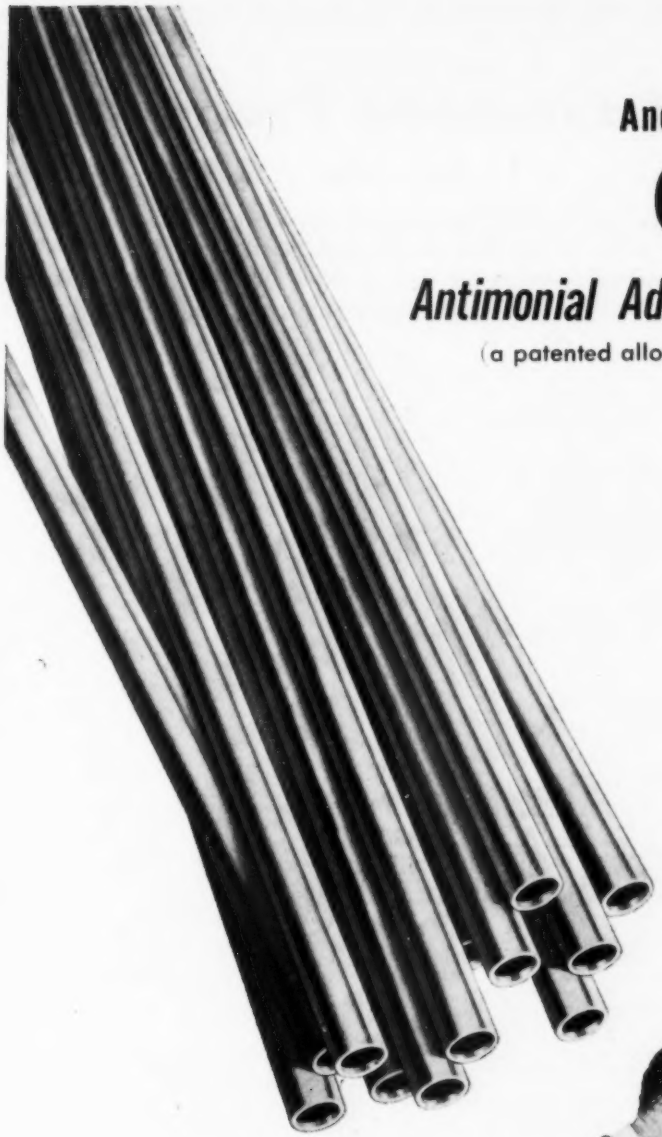

*Meet*
**WIDELY VARYING NEEDS...**

**IN THE WHOLE SPHERE of adsorbents and desiccants there can be few uses to which Floridin products have not been successfully applied since 1910, when this company was established.**

**If you have a problem of selective adsorption—dehydration—decolorization—catalysis—in some one of the twenty specialized Floridin products—extruded Fullers Earth in various forms—activated Bauxite adapted to various processes—synthetic granular desiccants for precise laboratory requirements—in the Floridin catalog you will doubtless find an answer to your need. Your inquiry will be given careful, competent attention.**

**FLORIDIN COMPANY**
ADSORBENTS DESICCANTS DILUENTS

**Dept. E, 220 Liberty Street, Warren, Pa.**



## Another reason why

# Chase

## *Antimonial Admiralty* Tubes last longer!*

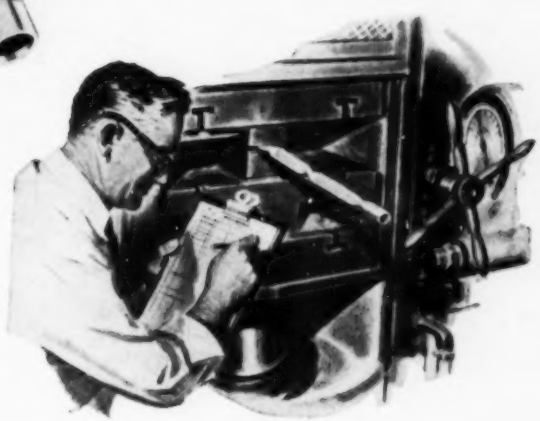
(a patented alloy)

Yes, you can *count* on Chase Antimonial Admiralty Heat Exchanger Tubes to give you many years of satisfactory service.

Chase Heat Exchanger Tubes are rigidly controlled for quality during manufacture, and various tests are applied when the tube is finished. The flattening test mentioned below is a good example. Wall thickness, diameter, surface finish, concentricity and accuracy of length are carefully determined.

So, for Heat Exchanger tubes that last and last, *remember:* insist on Chase Antimonial Admiralty!

*U.S. Pat. No. 2,061,921



**PUTTING THE SQUEEZE ON IMPERFECTIONS...**

This Chase technician is performing a "flattening test" which is an indication of soundness and freedom from hidden defects. You are assured that tubes passing this test will satisfactorily withstand bending or end flaring.

Chase® **BRASS & COPPER**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

**CHASE WAREHOUSE STOCKS:**
NEW YORK, BALTIMORE,
NEW ORLEANS, LOS ANGELES

***Also carried by***
Vinson Supply Co., Tulsa,
Standard Brass & Mfg. Co., Houston.

• *The Nation's Headquarters for Brass & Copper* Albany† Atlanta Baltimore Boston Chicago Cincinnati Cleveland Dallas Denver Detroit Houston Indianapolis
Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester† St. Louis San Francisco Seattle Waterbury †sales office only

Here's More

# Information on Advertised Products

**SAVE TIME . . .**

**By using the free and convenient Reader Service Postcards on opposite page. Circle on the card the identifying key number listed below for each advertisement in this issue on which additional data are desired.**

**IT'S FAST, CONVENIENT, CERTAIN**


**A**

(A1) The Air Preheater Corp. ..... 25
(A2) Airetool Manufacturing Co. ..... IV Cover
(A3) Albina Engine & Machine Works, Inc. ..... 256
(A4) Allis-Chalmers Manufacturing Co. ..... 38-39
(A5) Allis-Chalmers Manufacturing Co. ..... 41
(A6) Alloy Steel Products Co. ..... 4
(A7) Aluminum Company of America ..... 188-189
(A8) American Cyanamid Co. ..... 74
(A9) American District Steam Co. ..... 50
(A10) American Locomotive Co. ..... 102-103
(B1) American Locomotive Co. ..... 211
(B2) American Recording Chart Co. ..... 271
(B3) American Sand-Banum Co. ..... 267
(B4) The Annin Company ..... 43
(B5) Attapulgus Minerals & Chemicals Corp. ..... 46
(B6) Aurora Pump Co. ..... 278

**B**

(B7) The Babcock & Wilcox Co., Tubular Products Division ..... 207
(B8) Badger Manufacturing Co. ..... 240
(B9) Badger Manufacturing Co. ..... 261
(B10) Barco Manufacturing Co. ..... 250
(C1) The J. B. Beaird Co. ..... Insert 112-113
(C2) Bethlehem Steel Co. ..... 251
(C3) W. H. & L. D. Betz ..... 249
(C4) Bigelow-Liptak Corp. ..... 79
(C5) Black, Sivalls & Bryson, Inc. ..... 237
(C6) Blaw-Knox Co. ..... 24
(C7) Blaw-Knox Co. ..... 216
(C8) Blaw-Knox Co. ..... 283
(C9) Bridgeport Brass Company ..... 247
(C10) The Bristol Co. ..... 16
(D1) The Brown Fintube Co. ..... 236
(D2) Bucyrus-Erie Co. ..... 235

**C**

(D3) The Chapman Valve Manufacturing Co. ..... 244
(D4) Chase Brass & Copper Co. ..... 191
(D5) Chemical Construction Corp. ..... 64
(D6) Cities Service Co. ..... Opp. 65
(D7) Clark Bros. Co. ..... 12-13
(D8) Clark Equipment Co. ..... 245
(D9) The Clark Manufacturing Co. ..... 198
(D10) Consolidated Chemical Industries, Inc. ..... 106
(E1) Corning Glass Works ..... 217
(E2) Crane Company ..... 185
(E3) Croll-Reynolds Co. ..... 260
(E4) Crouse-Hinds Co. ..... 62

**D**

(E5) Davis Engineering Corp. ..... 234
(E6) The Davison Chemical Corp. ..... 242-243
(E7) Dean Brothers Pumps, Inc. ..... 263
(E8) Dean Hill Pump Co. ..... 65
(E9) De Laval Steam Turbine Co. ..... 47
(E10) Dempster Brothers, Inc. ..... 49
(F1) John Dollinger, Jr., Inc. ..... 266
(F2) Dresser Industries, Inc. ..... Insert 96-97
(F3) E. F. Drew & Company, Inc. ..... 205
(F4) E. I. du Pont de Nemours & Co. ..... 33
(F5) E. I. du Pont de Nemours & Co. ..... 90
(F6) E. I. du Pont de Nemours & Co. ..... Insert 224-252
(F7) The Duraloy Co. ..... 265
(F8) Durametallic Corp. ..... 278

**E**

(F9) Elliott Co. ..... 23
(F10) Elliott Co. ..... 92
(G1) Elliott Co. ..... 241
(G2) The Elwell-Parker Electric Co. ..... Opp. 96

**F**

(G3) Filtrol Corp. ..... Opp. 97
(G4) Fisher Governor Co. ..... 14
(G5) Flexitallic Gasket Co. ..... 104
(G6) Floridin Co. ..... 190
(G7) The Fluor Corp. ..... 199
(G8) Forty-Eight Insulations, Inc. ..... 200
(G9) The Foxboro Co. ..... 60-61

**G**

(G10) The Garlock Packing Co. ..... 87
(H1) Gasoline Plant Construction Corp. ..... 78
(H2) Claude S. Gordon Co. ..... 284
(H3) Graver Tank & Mfg. Co. ..... 208
(H4) A. P. Green Fire Brick Co. ..... 75
(H5) Grinnell Company, Inc. ..... 67
(H6) Griscom-Russell Co. ..... 42
(H7) Gunite Concrete and Construction Co. ..... 280

**H**

(H8) D. W. Haering & Co., Inc. ..... 272
(H9) Hammel-Dahl Co. ..... 17
(H10) Hardinge Company, Inc. ..... 270
(J1) Hetherington & Berner, Inc. ..... 283
(J2) Hills-McCanna Co. ..... 218
(J3) Hudson Engineering Corp. ..... 203
(J4) Hydrocarbon Research, Inc. ..... 112

**I**

(J5) Ingersoll-Rand Co. ..... 18
(J6) Insul-Mastic Corporation of America ..... 9
(J7) International Engineering, Inc. ..... 206
(J8) The International Nickel Co. ..... 287

**J**

(J9) The C. O. Jelliff Mfg. Co. ..... 279
(J10) Jerguson Gage & Valve Co. ..... 221

**K**

(K1) Keasbey & Mattison Co. ..... 110
(K2) The M. W. Kellogg Co. ..... 73
(K3) The M. W. Kellogg Co. ..... Insert 32-33
(K4) The M. W. Kellogg Co. ..... Insert 256-257
(K5) The C. M. Kemp Manufacturing Co. ..... 82
(K6) Killark Electric Mfg. Co. ..... 279
(K7) Kinney Manufacturing Co. ..... 281
(K8) Koch Engineering Co. ..... III Cover
(K9) Koppers Co. ..... 273

**L**

(K10) Ladish Company ..... Opp. 64
(L1) Layne & Bowler, Inc. ..... 101
(L2) Leeds & Northrup Co. ..... 8
(L3) Warner Lewis Co. ..... 281
(L4) Lukens Steel Co. ..... 66
(L5) The Lummus Co. ..... 53
(L6) The Lummus Co. ..... 255

**M**

(L7) Maintenance Engineering Corp. ..... 15
(L8) Manning, Maxwell & Moore, Inc. ..... 48
(L9) Marlow Pumps ..... 275
(L10) The Mason-Neilan Co. ..... 98-99
(M1) The Master Electric Co. ..... 58
(M2) Arthur G. McKee & Co. ..... 213
(M3) Metal Goods Corp. ..... 40
(M4) Metal Textile Corp. ..... 94
(M5) Milton Roy Co. ..... 54
(M6) Mine Safety Appliances Co. ..... 264
(M7) Minneapolis-Honeywell Regulator Co. ..... 36-37
(M8) Mixing Equipment Co. ..... 88
(M9) Samuel Moore & Co. ..... 260
(M10) Murray Iron Works Co. ..... 282

**N**

(N1) National Airoil Burner Co. ..... 284
(N2) National Aluminate Corp. ..... 223
(N3) National Foam System, Inc. ..... 69
(N4) National Tube Division United States Steel Corp. ..... 232
(N5) W. H. Nicholson & Co. ..... 282
(N6) W. C. Norris, Manufacturer, Inc. ..... 108
(N7) Norton Co. ..... 28

**O**

(N8) Oakite Products, Inc. ..... 262
(N9) The Ohio Steel Foundry Co. ..... 202
(N10) O-I Well Supply Division United States Steel Corp. ..... 5
(P1) Okadee Company ..... 254
(P2) Orbit Valve Co. ..... 86

**P**

(P3) Pacific Coast Borax Co. ..... 274
(P4) Peerless Pump Division Food Machinery & Chemical Corp. ..... 29
(P5) Pennsylvania Flexible Metallic Tubing Co. ..... 59
(P6) Petro-Chem Development Co. ..... 201
(P7) Petrolite Corp. ..... 83
(P8) Phelps Dodge Refining Corp. ..... 276
(P9) Philadelphia Gear Works, Inc. ..... 229
(P10) Pittsburgh Lectrodryer Corp. ..... 85
(Q1) Platecoil Division Kold-Hold Manufacturing Co. ..... 214
(Q2) Posey Iron Works, Inc. ..... 68
(Q3) The Wm. Powell Co. ..... 57
(Q4) The Pressed Steel Co. ..... 32
(Q5) Procon, Inc. ..... 44-45
(Q6) %Proportioneers, Inc.% ..... II Cover
(Q7) Pyrene Manufacturing Co. ..... 246

**R**

(Q8) R-S Products Corp. ..... 219
(Q9) The George Rackle & Sons Co. ..... 266
(Q10) Reading-Pratt & Cady Division American Chain & Cable Co. ..... 225
(R1) The Refinery Catalog ..... 51
(R2) The Refinery Engineering Co. ..... 76-77
(R3) Republic Steel Corp. ..... 31
(R4) Republic Steel Corp. ..... 288
(R5) Revere Copper and Brass, Inc. ..... 183
(R6) The Ridge Tool Co. ..... 228
(R7) Rochester Manufacturing Co. ..... 257
(R8) W. S. Rockwell Co. ..... 280
(R9) Rockwell Manufacturing Co. ..... Insert 80-81
(R10) Rockwell Sprinkler Co. ..... 227
(S1) Roots-Connersville Blower Corp. ..... 230

**S**

(S2) Sarco Company, Inc. ..... 34
(S3) Schapansky and King ..... 264
(S4) Scoville Manufacturing Co. ..... 238
(S5) Sealol Corp. ..... 277
(S6) Selas Corporation of America ..... 253
(S7) Shell Development Co. ..... 81
(S8) The Sherwin-Williams Co. ..... 248
(S9) Sims Pump Valve Co. ..... 266
(S10) A. O. Smith Corp. ..... 7
(T1) Solvay Process Division Allied Chemical & Dye Corp. ..... 63
(T2) Southern Engine & Pump Co. ..... 279
(T3) Standard Oil Co. of California ..... 80
(T4) Strong, Carlisle & Hammond Co. ..... 264
(T5) Struthers Wells Corp. ..... 22
(T6) Sun Shipbuilding & Dry Dock Co. ..... 231

**T**

(T7) Taylor Forge & Pipe Works ..... 220
(T8) Taylor Instrument Companies ..... 258-259
(T9) The Telecomputing Corp. ..... 55
(T10) The Terry Steam Turbine Co. ..... 71
(U1) Texas Employers Insurance Assoc. ..... 70
(U2) The Timken Roller Bearing Co. ..... 6
(U3) Tracerlab, Inc. ..... 268
(U4) Tri-State Manufacturing & Engr. Co. ..... 266

**U**

(U5) United States Rubber Co. ..... 195
(U6) United States Steel Corp. ..... 26-27
(U7) U. S. Stoneware Co. ..... 35
(U8) Universal Oil Products Co. ..... 196-197

**V**

(U9) The Van Dorn Iron Works Co. ..... 262
(U10) Victor Products Corp. ..... 267
(V1) Henry Vogt Machine Co. ..... 186

**W**

(V2) W-K-M Company ..... 215
(V3) Wallace & Tiernan Products, Inc. ..... 252
(V4) Walworth Company ..... 52
(V5) Warren Petroleum Corp. ..... I Cover
(V6) Water Cooling Equipment Co. ..... 239
(V7) Watson-Stillman Fittings Division H. K. Porter Co., Inc. ..... 21
(V8) Wedgeplug Valve Co. ..... 96
(V9) Weston Electrical Instrument Corp. ..... 226
(V10) The Whitlock Manufacturing Co. ..... 269
(X1) The Gustav Wiedeke Co. ..... 280
(X2) Williams Gauge Co. ..... 210
(X3) Thomas C. Wilson, Inc. ..... 84
(X4) Wolverine Tube Division Calumet & Hecla, Inc. ..... 56
(X5) Worthington Corp. ..... 10
(X6) Worthington Corp. ..... 11
(X7) Wyatt Metal & Boiler Works ..... 19

**Y**

(X8) Yarnall-Waring Co. ..... 30

# What's New in Manufacturers' Literature

**For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.**

### Research Laboratories

Advantages of employing an integrated company to design and construct research laboratories for industry are stressed in a new, eight-page brochure issued by Walter Kidde Constructors, Inc. The booklet describes successful research laboratories designed and built by Walter Kidde in such fields as foods, electronics, paints and chemicals.

*Circle No. 1 on Postcard*

### Air-Cooled Heat Exchanger

The Fluor Fin-Fan air-cooled heat exchanger is the subject of a new bulletin issued by The Fluor Corporation, Ltd. The unit, according to the pamphlet, has wide adaptability for every cooling service where the final fluid temperature required is higher than dry bulb air temperature. It is particularly adaptable in those areas where water cooling involves problems of supply, cost, scale, corrosion and other difficulties.

Fin-Fan air-cooled heat exchangers are individually sized for each heat transfer problem and for best utilization of available space. They can be multi-pass, connected in series for long temperature ranges, in parallel for large capacities or in combinations to best suit the cooling requirements. Single-cell and multi-cell units are frequently used for two or more duties.

These exchangers are of the forced-draft type with independently mounted fan, gear and driver assemblies located under the cooling surface to blow air upward and across finned-tubes carrying the medium to be cooled. The Fin-Fan is designed to cool liquids or gases at pressures up to 5000 psi and temperatures up to 1500 F.

*Circle No. 2 on Postcard*

### Radioactivity Data

A comprehensive survey of the many applications of radioactivity in the petroleum industry is contained in a new booklet published by Tracerlab, Inc. The 16-page brochure contains brief descriptions of the diverse uses to which radioactivity has been applied, coupled with literature references. A three-page bibliography is included.

*Circle No. 3 on Postcard*

### Flexible Gear Couplings

New Sier-Bath flexible gear couplings are described in a catalog just released by Sier-Bath Gear & Pump Company, Inc. Called catalog C 4, it lists the advantages, typical applications, standard types, special types and engineering data of Sier-Bath couplings.

Among the advantages of the couplings: more horsepower with less size and weight; assembled and uncoupled in seconds; no wrenches or special tools required; and safe and silent as smooth shafting.

*Circle No. 4 on Postcard*

USE THESE CARDS
To Get
COPIES OF CATALOGS
And for More
Information on
NEW EQUIPMENT
ADVERTISED PRODUCTS

## EASY TO USE . . . FREE

**Circle on one of the cards at right the identifying numbers of each new equipment and catalog item or advertised product on which you want more information. Print your name and address plainly. Tear out and mail card. That's all there is to it. No postage is required if card is mailed in U.S.A. Your request will be forwarded promptly to the company concerned, and the reply will come direct to you.**

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary If Mailed in the United States

## BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
**REFINER**

BOX 2608

HOUSTON 1, TEXAS, U. S. A.

**PETROLEUM REFINER Reader Service Postcard—May, 1953, issue***

**EDITORIAL ITEMS—Circle item numbers on which more information desired:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 4 | 7 | 10 | 13 | 16 | 19 | 22 |
| 2 | 5 | 8 | 11 | 14 | 17 | 20 | 23 |
| 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 |

**ADVERTISEMENTS—Circle key number of ad for more product information:**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | B1 | C1 | D1 | E1 | F1 | G1 | H1 | J1 | K1 | L1 | M1 | N1 | P1 | Q1 | R1 | S1 | T1 | U1 | V1 | X1 |
| A2 | B2 | C2 | D2 | E2 | F2 | G2 | H2 | J2 | K2 | L2 | M2 | N2 | P2 | Q2 | R2 | S2 | T2 | U2 | V2 | X2 |
| A3 | B3 | C3 | D3 | E3 | F3 | G3 | H3 | J3 | K3 | L3 | M3 | N3 | P3 | Q3 | R3 | S3 | T3 | U3 | V3 | X3 |
| A4 | B4 | C4 | D4 | E4 | F4 | G4 | H4 | J4 | K4 | L4 | M4 | N4 | P4 | Q4 | R4 | S4 | T4 | U4 | V4 | X4 |
| A5 | B5 | C5 | D5 | E5 | F5 | G5 | H5 | J5 | K5 | L5 | M5 | N5 | P5 | Q5 | R5 | S5 | T5 | U5 | V5 | X5 |
| A6 | B6 | C6 | D6 | E6 | F6 | G6 | H6 | J6 | K6 | L6 | M6 | N6 | P6 | Q6 | R6 | S6 | T6 | U6 | V6 | X6 |
| A7 | B7 | C7 | D7 | E7 | F7 | G7 | H7 | J7 | K7 | L7 | M7 | N7 | P7 | Q7 | R7 | S7 | T7 | U7 | V7 | X7 |
| A8 | B8 | C8 | D8 | E8 | F8 | G8 | H8 | J8 | K8 | L8 | M8 | N8 | P8 | Q8 | R8 | S8 | T8 | U8 | V8 | X8 |
| A9 | B9 | C9 | D9 | E9 | F9 | G9 | H9 | J9 | K9 | L9 | M9 | N9 | P9 | Q9 | R9 | S9 | T9 | U9 | V9 | X9 |
| A10 | B10 | C10 | D10 | E10 | F10 | G10 | H10 | J10 | K10 | L10 | M10 | N10 | P10 | Q10 | R10 | S10 | T10 | U10 | V10 | X10 |

Name (Please Print)_____

Company_____ Position_____

Address_____

MAIL IT NOW . . . *CARD EXPIRES AUGUST 10, 1953

# What's New in Manufacturers' Literature

**Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested**

### Temperature Controls

Burlington Instrument Company's electric temperature controls are described in a new four-page folder. This condensed Catalog G-18 pictures all models including Models A-1S and B-1C and gives a separate description of the company's pneumatic and valve type controls. For the first time, a comprehensive selection and comparison table has been added, showing the essential features of each of the 17 electrically operated temperature controls. Included are the one, two and three switch models, some of which are suitable for 1800 F.

The catalog will be supplemented during the year by individual specification sheets, covering the various models in greater detail than has any previous literature.

*Circle No. 5 on Postcard*

### Tubing Steel

B&W Croloy 5 (4-6 percent Chromium, ½ percent Molybdenum) is discussed in a new technical data card issued by the Tubular Products division of The Babcock & Wilcox Company. Known as TDC-146, this alloy tubing steel is widely used in elevated temperature service.

The value of the steel has been proved in refinery and other process industry applications as furnace tubes, piping and superheater tubing. It is particularly resistant to corrosion from hot oil, hydrogen sulfide, elementary sulfur and organic sulfur compounds as encountered in petroleum processing, the manufacturer claims.

Included in the bulletin are data on mechanical properties, creep strength, physical properties, welding, fabrication and heat treatment.

*Circle No. 6 on Postcard*

### Recorders And Controllers

Two new catalogs have been issued by Leeds & Northrup Company.

Catalog ND44(1), "Micromax Model S Indicating Recorders and Controllers," describes in detail the design and construction features of the strip-chart Model S Micromax Recorder. The revised, 40-page publication presents interior views of the Micromax instrument and presents: 1) the sequence of galvanometer detection; 2) typical circuits used; 3) standard features found in the basic Micromax instrument; and 4) special features available. A handy margin-index simplifies locating the individual sections of the catalog.

Catalog ND47, "Electromax Temperature and Conductivity Controllers," contains complete data about moderate-priced electronic instruments for Two-Position or Proportional Control. The 20-page publication shows how three types of Electromax Temperature Controllers are being used to regulate temperatures up to 1000 F. It also describes an Electromax Conductivity Controller that is being used to check condensate purity. The catalog includes pictures of typical Electromax installations.

*Circle No. 7 on Postcard*

### Welding Equipment

Equipment and supplies used in Aircomatic welding, Air Reduction's inert-gas-shielded metal-arc process, are described in a new, 12-page booklet. In two colors, it covers in detail both the No. 3 and the new No. 20 annual Aircomatic Guns and the Aircomatic Head for automatic operation. Aircomatic wires for use with this equipment are also covered.

*Circle No. 8 on Postcard*

(More Literature Items on Pages 193, 194, 198, 200, 202)

**PETROLEUM REFINER Reader Service Postcard—May, 1953, Issue***

EDITORIAL ITEMS—Circle item numbers on which more information desired:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 4 | 7 | 10 | 13 | 16 | 19 | 22 |
| 2 | 5 | 8 | 11 | 14 | 17 | 20 | 23 |
| 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 |

ADVERTISEMENTS—Circle key number of ad for more product information:

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | B1 | C1 | D1 | E1 | F1 | G1 | H1 | J1 | K1 | L1 | M1 | N1 | P1 | Q1 | R1 | S1 | T1 | U1 | V1 | X1 |
| A2 | B2 | C2 | D2 | E2 | F2 | G2 | H2 | J2 | K2 | L2 | M2 | N2 | P2 | Q2 | R2 | S2 | T2 | U2 | V2 | X2 |
| A3 | B3 | C3 | D3 | E3 | F3 | G3 | H3 | J3 | K3 | L3 | M3 | N3 | P3 | Q3 | R3 | S3 | T3 | U3 | V3 | X3 |
| A4 | B4 | C4 | D4 | E4 | F4 | G4 | H4 | J4 | K4 | L4 | M4 | N4 | P4 | Q4 | R4 | S4 | T4 | U4 | V4 | X4 |
| A5 | B5 | C5 | D5 | E5 | F5 | G5 | H5 | J5 | K5 | L5 | M5 | N5 | P5 | Q5 | R5 | S5 | T5 | U5 | V5 | X5 |
| A6 | B6 | C6 | D6 | E6 | F6 | G6 | H6 | J6 | K6 | L6 | M6 | N6 | P6 | Q6 | R6 | S6 | T6 | U6 | V6 | X6 |
| A7 | B7 | C7 | D7 | E7 | F7 | G7 | H7 | J7 | K7 | L7 | M7 | N7 | P7 | Q7 | R7 | S7 | T7 | U7 | V7 | X7 |
| A8 | B8 | C8 | D8 | E8 | F8 | G8 | H8 | J8 | K8 | L8 | M8 | N8 | P8 | Q8 | R8 | S8 | T8 | U8 | V8 | X8 |
| A9 | B9 | C9 | D9 | E9 | F9 | G9 | H9 | J9 | K9 | L9 | M9 | N9 | P9 | Q9 | R9 | S9 | T9 | U9 | V9 | X9 |
| A10 | B10 | C10 | D10 | E10 | F10 | G10 | H10 | J10 | K10 | L10 | M10 | N10 | P10 | Q10 | R10 | S10 | T10 | U10 | V10 | X10 |

Name (Please Print)_____

Company_____ Position_____

Address_____

MAIL IT NOW . . . *CARD EXPIRES AUGUST 10, 1953

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary If Mailed in the United States

**BUSINESS REPLY CARD**

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

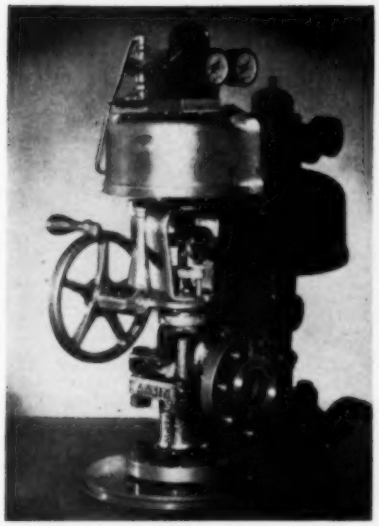
PETROLEUM **REFINER**

BOX 2608

HOUSTON 1, TEXAS, U. S. A.

**USE THESE CARDS**
To Get
**COPIES OF CATALOGS**
And for More
Information on
**NEW EQUIPMENT**
**ADVERTISED PRODUCTS**

# [ What's New in Equipment ]



## Versatile Control Valve

A new combination automatic and manual control valve has been developed by The Annin Company. Available in models 1520 SMW and 1560 SMW, it utilizes the advantages of its powerful Domotor control unit plus the "versatility of handwheel operation."

According to the company, its engineers developed the side-mounted handwheel in answer to field demands for convenient and positive supplementary control during start-up periods, or when the system is shut down temporarily.

Major applications of the auxiliary manual control are in adjusting the flow of steam to turbines and steam engines, fuel to engines, and when batches are being processed intermittently.

**This item supplements The Annin Company data on pages 150-151 of The Refinery Catalog, 20th Edition.**

*Circle No. 9 on Postcard*

## Modernized Pump Line

Peerless Pump Division, Food Machinery and Chemical Corporation, has modernized and consolidated its complete line of 2, 3, 4 and 5-stage split-case pumps. These pumps are designed to supply, circulate and boost water and clear liquids at medium and high heads, with emphasis on product quality and long life rather than low initial price.

Designated as Type TU, this line of pumps is offered in 2-stage designs with capacities up to 3000 gallons per minute and heads up to 800 feet and for liquid temperatures up to 300 F. Case pressures for the 2-stage pumps range from 300 to 400 pounds. Drivers of up to 325 bhp can be applied. In discharge sizes up to and including four-inch discharge, the crossover between stages is built integrally with the top part of the pump case. In discharge sizes over four inches, the high loop crossover between stages is used, extending over and above the top half of the pump case.

Specifications for the 3-stage design provide head ranges to 950 feet and capacities up to 1400 gpm; 4-stage specifications provide head ranges to 1600 feet and capacities up to 900 gpm; and 5-stage specifications provide head ranges to 1550 feet and capacities up to 300 gpm. Liquid temperatures up to 300 F. can be handled by these three types.

Pumps in the TU line are of the split-case type with the split at the centerline of the pump. The entire rotating element of the pump can be removed for inspection and repair without disturbing the pump alignment or piping. Standard construction is cast iron, bronze fitted, but cases may be obtained in steel, all bronze or other alloys. All pumps are fitted with both case and impeller wear rings and shaft sleeves. Heavy-duty ball bearings, grease lubricated, are provided.

**This item supplements Peerless Pump Division, Food Machinery and Chemical Corporation, data on pages 838-839 of The Refinery Catalog, 20th Edition.**

*Circle No. 10 on Postcard*

## Leak-Proof Tube Fitting

Ermeto patented tube fittings have been manufactured by The Weatherhead Company to provide "a more positive seal than flared or compression type fittings." It requires no flaring, no threading, no welding and no soldering. Ermeto requires no special tools or special preparation for installation.

The tube fitting consists of a sleeve, nut and tapered body. As the nut is tightened, it forces the sleeves forward into the taper of the body. The leading edge of the sleeve contracts, thus forcing the cutting edge to shear a slight groove into the outer surface of the tubing. This provides "a leak-proof joint between the Ermeto fitting and tube." The nut, pressing on the bevel of the sleeve, results in a tight, positive grip on the tube. When fully tightened, the sleeve is bowed slightly at the middle, causing it to act as a lockwasher. This locking action maintains constant tension between the body and nut thereby preventing loosening of the nut. Once the fitting has been assembled, the sleeve becomes permanently attached to the tube. Disassembly and reassembly of the fitting can be made without loss of the sealing quality.

**This item supplements The Weatherhead Company data on page 1015 of The Refinery Catalog, 20th Edition.**

*Circle No. 11 on Postcard*

## Steel Castings

Comprehensive data detailing applications of steel castings are made available in booklet form by Steel Founders' Society of America. The publication emphasizes the reliability, strength and versatility of steel castings as an engineering material widely used in more than 100 vital industries.

Reprinted in manual format, "Carbon and Low Alloy Steel Castings" incorporates data of value to the materials engineer, design and production engineering organizations, purchasing departments, engineering students and others active in design and processing and specifications categories.

Included is material covering steel casting properties, specifications, design, joining, heat treating and inspection procedures. A two-page chart is devoted to general engineering types of steel castings, classified according to tensile strengths.

*Circle No. 12 on Postcard*

## Portable Joint Cleaner

A new high speed joint cleaner that automatically cleans inside or outside pipe ends or threaded joints in six to eight seconds has been announced by The Airetool Manufacturing Company.

Designed to speed reconditioning of old or reclaimed well pipe and pipe lines, it requires no change-over of equipment to clean inside or outside. The manufacturer claims it will clean pipe ends from two to ten inches.

The new joint cleaner has a wire brush head that revolves around the pipe ends to remove all deposits. It has a provision for shooting a solvent or cleaning fluid onto the pipe end to dissolve the caked material. It consists of an air-driven motor and a precessing (cq) head containing a spring loaded brush guide and wire brush.

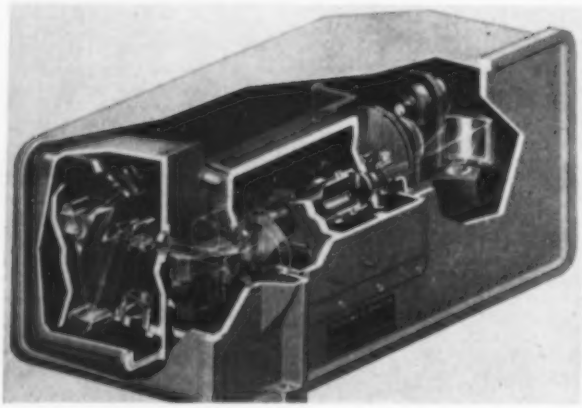
The motor is a single stage, air-driven type, slip-fit constructed. It is muffled and provision is made for proper lubrication. The brush head consists of a two-inch replaceable wire brush. The cleaner precessing (cq) head revolves around the pipe end at 40 rpm. The entire unit weighs 16 pounds.

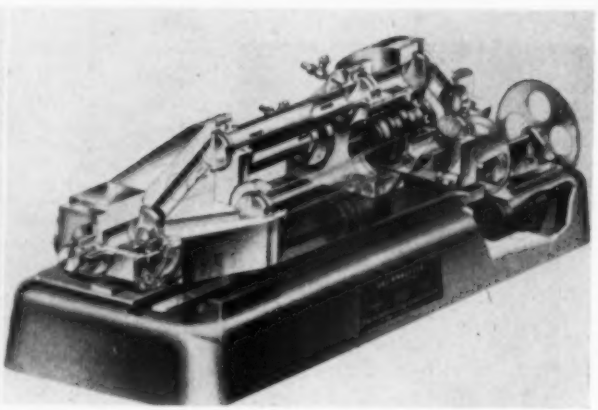
The Airetool joint cleaner has a use wherever pipe is to be reclaimed or reconditioned. It can save many hours and many dollars on pipe reconditioning programs.

**This item supplements The Airetool Manufacturing Company data on pages 69-88 of The Refinery Catalog, 20th Edition.**

*Circle No. 13 on Postcard*

# [ What's New in Equipment ]





## New Infrared Analyzers

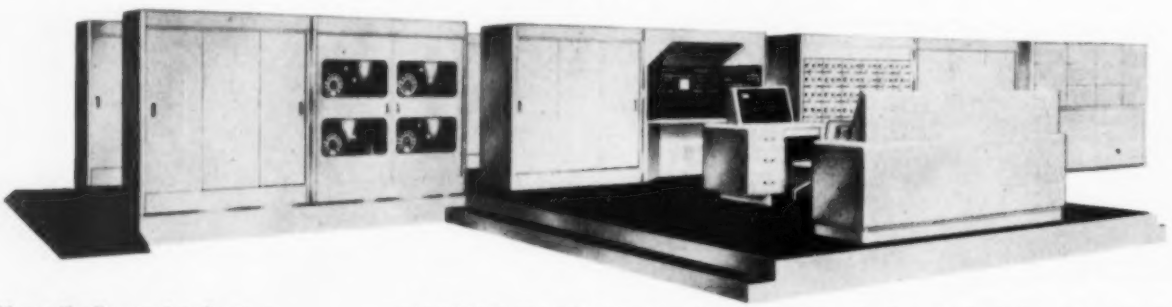
Two new infrared analyzers specifically designed to analyze the constituents of chemical plant process streams and to make possible continuous control of these streams have been announced by The Perkin-Elmer Corporation.

The first new instrument is the Model 93 Bichromator Analyzer (left above), a two-color wavelength analyzer. It consists of three basic units; source, monochromator and detector, and sample cell. The first two are separately enclosed and pressurized with electrical connections as the only entrant members. In operation the Bichromator Analyzer permits the selection of two analytical wavelengths. By an optical principle, the instrument gives a continuous measure of the ratio of radiation present at the two selected wavelengths. Thus the operation of the instrument is essentially that of base-line density analysis and is relatively invariant to changes in source temperature or sample cell transmission.

The Model 105 Tri-Non Analyzer is a selective triple beam, non-dispersion analyzer. The cell paths can be filled with various components of the process stream under analysis and the instrument sensitized to cancel out the effects of component interference.

Both instruments are thermostated to operate between 0 and 120 F. Each is mounted in an explosion-proof case that meets Class I, Group D safety requirements. On each unit the signal appears as a shaft position and may be transmitted to a recorder remotely located from the analyzers.

*Circle No. 14 on Postcard*



## Versatile Computing System

A move towards completely automatic control of industrial processes has been made with the new ultra-high speed "ERA 1103" general purpose electronic digital computing system announced by the Engineering Research Associates division of Remington Rand Inc.

Developed originally for the U. S. government, the "ERA 1103" provides storage capacity up to 17,408 superspeed registers plus unlimited supplementary magnetic tape bulk storage, high operating speed (60 micro-seconds per unit of addition) and wide programming versatility. First commercial models are available for delivery in 1954.

Among potential applications of this device, in addition to automatic process control, are: air traffic control and air defense, aircraft simulation, automatic data reduction, general industrial and economic planning and scientific-mathematical computation.

The new computor will make it possible, the company reports, to apply automatic processing to a large oil refinery or chemical plant. The machine will receive data on the processing through "sensing" devices at various stages in the operation. These data would be processed in the computor in accordance with instructions previously fed in.

The "ERA 1103" computor system is housed in chrome-oramented cabinets occupying an area slightly smaller than the ground floor of an average house. It weighs about ten tons. Though large and electronically complex, the system, with 4500 electron tubes, operates on less power than four double-oven electric ranges.

*Circle No. 15 on Postcard*

## Diaphragm Motor Valve

The Minneapolis-Honeywell Regulator Company's Series 100 Diaphragm Motor Valve is described in a new specification sheet. Referred to as sheet 419-2, the folder claims that the valve provides optimum narrow-band proportional control at minimum cost. It gives pertinent data such as size, construction and body pressure range.

*Circle No. 16 on Postcard*

## Liquid Level Gages

Nine sheets covering a complete line of liquid level gage valves for both tubular and flat gages, regular, offset and with union connections to gage have been made available by Jerguson Gage & Valve Company. This set of new data units includes complete specifications with illustrations showing cross sections, roughing dimensions and the standard and optional connections available.

*Circle No. 17 on Postcard*

## Pumps, Motors and Generators

Allis-Chalmers Manufacturing Company has released two new booklets.

The company's single-stage, double-suction centrifugal pumps (Type S) are described in newly revised Bulletin 98B6146B. The pumps, made in 66

# New BROCHURE!

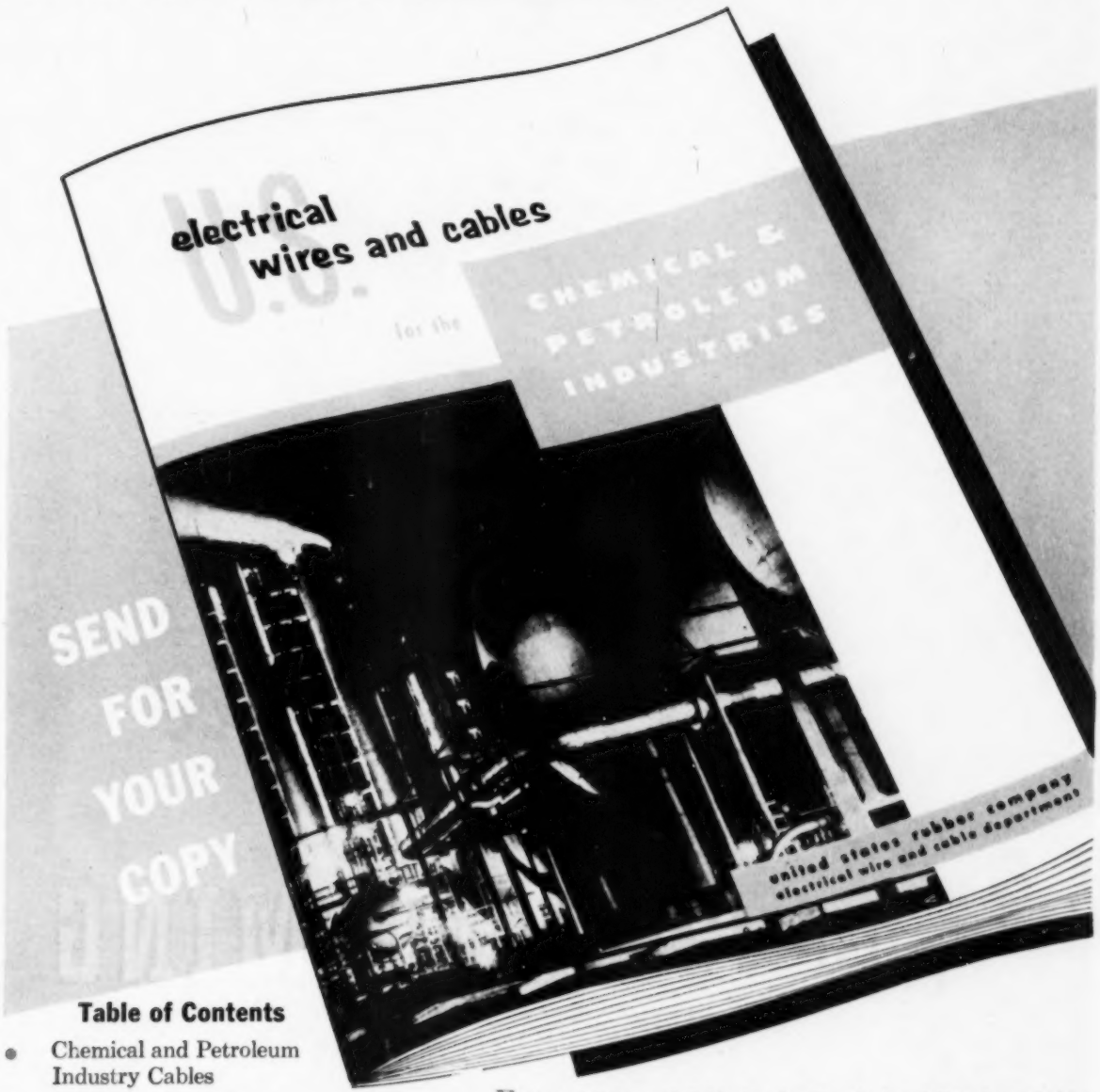



**Table of Contents**

- Chemical and Petroleum Industry Cables
- Insulation Compounds
- Jacket Compounds
- Portable Cables
- Power Cables
- Control Cables
- Telephone Cables
- Tables

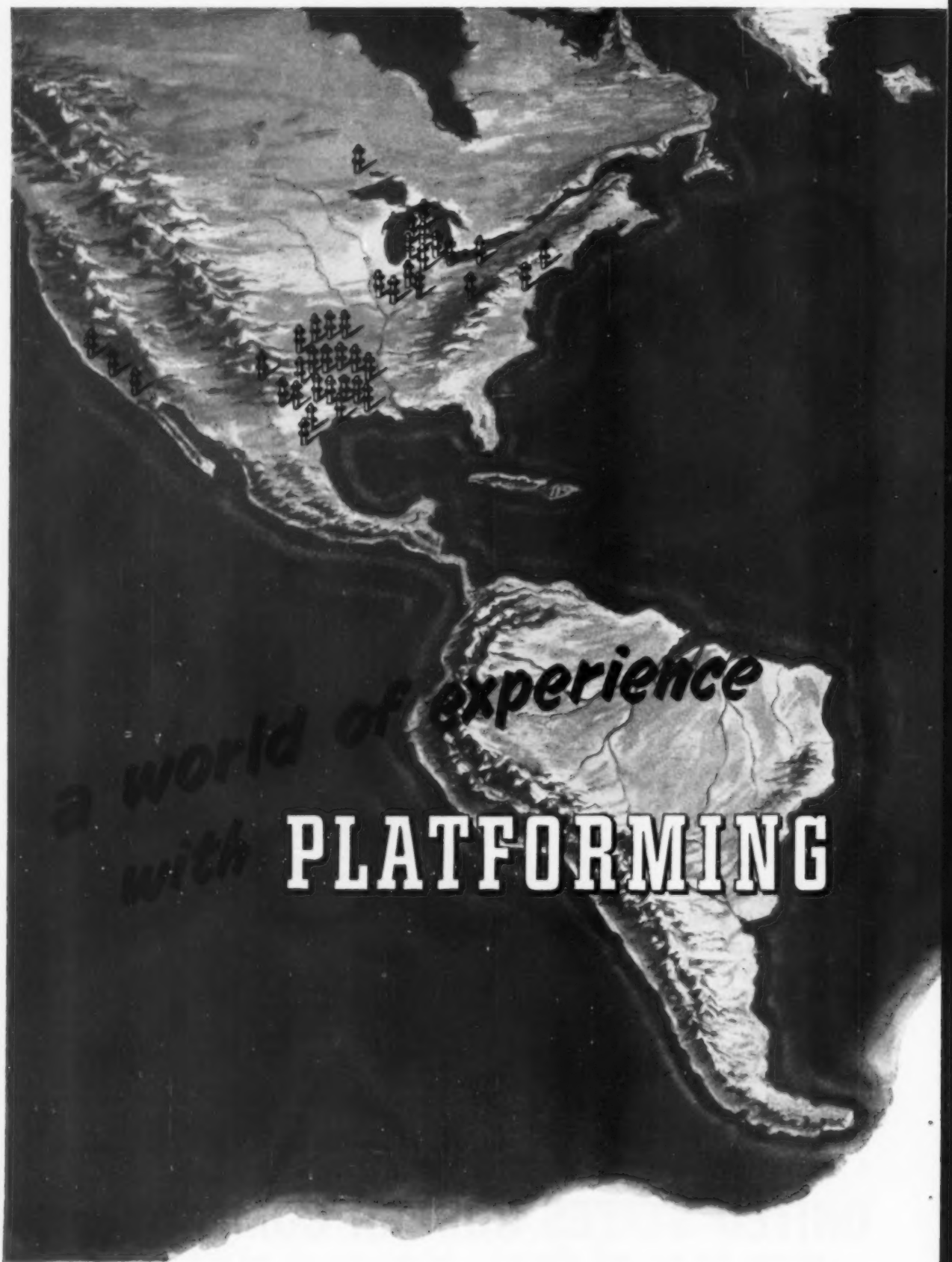
Electrical Wire and Cable for the Chemical and Petroleum Industries must have the right chemical, oil and corrosion-resistant insulations plus the right electrical and physical properties for the job. Insulations and jackets which may be excellent for one type of service may be unsatisfactory in another. United States Rubber Company, a specialist in manufacturing the *right* electrical wires and cables for the Chemical and Petroleum Industries, is the only wire and cable manufacturer growing its own natural rubber, making its own synthetic and plastic insulations.

The brochure shown above shows what "U.S." wires and cables to order for specific applications. Write to address below for your free copy.

## UNITED STATES RUBBER COMPANY

U.S. RUBBER

**ELECTRICAL WIRE AND CABLE DEPARTMENT • Rockefeller Center, New York 20, N. Y.**


a world of experience
with
PLATFORMING

**52** UNITS — 21 on stream . . . 31 in design or under construction — a total of 39 in the U. S. A. . . . four in Japan . . . two each in Great Britain, Australia and the Middle East . . . one each in Canada, Canary Islands, and France. That's how far PLATFORMING has come since October 27, 1949 when the first unit went on stream at Muskegon, Mich.

Refiners all over the world have chosen PLATFORMING because it is the proved solution to their reforming problems . . . because it produces high octane fuel from low grade charge stocks . . . because it has the aromatics option . . . because it is versatile, economical, and dependable! You can rely on this world-wide experience in making *your* choice.

**UNIVERSAL OIL PRODUCTS COMPANY**

UOP

30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

Laboratories: RIVERSIDE, ILLINOIS

*Universal Service Protects Your* ***Investment***

Controlled Pressure

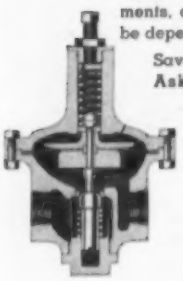
for efficient operation

**Clark Pressure Reducing and Regulating Valves**

are precision-made for positive pressure control on air, gas or steam lines.

Where different types of equipment, with varying pressure requirements, are operated from a common line, Clark Regulating Valves can be depended on to deliver automatically the "just right" pressure to each.

Save on fuel, maintenance and protect expensive equipment. Ask your Clark representative to specify the right Clark valves for your needs . . . or write us direct.

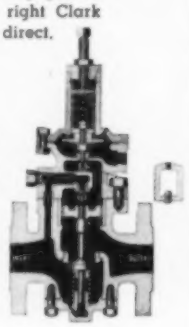


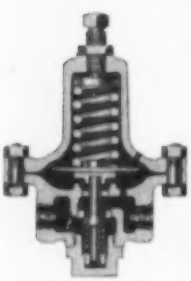
**TYPE KRV**

Pressure Reducing Valve. Diaphragm Operated-Single Seated Valve. Sizes ½" to 1½" for initial pressures up to 250 P.S.I. Reduced pressures to 85 P.S.I.

**TYPE CRV**

Pressure Reducing Valve. Integral pilot controlled, piston operated. For pressure control from "dead end" to full capacity. Sizes ½" to 6".





**TYPE ORV**

Pressure Reducing Valve. ⅜" and ½" Single Seated, Spring Loaded, Diaphragm Actuated. For initial pressures to 250 P.S.I. Reduced pressures to 200 P.S.I.

**QUICK-CLEANING STRAINERS**

Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" I.P.S. For pressures to 250 P.S.I.

THE HOME OF DUO-STEP LEVERAGE

Clark

MANUFACTURING COMPANY

1830 EAST 38th STREET

CLEVELAND 14, OHIO

*Distributors and Representatives in all major cities*


## *New Equipment . . .*

standard sizes, are individually engineered for customers, according to the publication. The pumps are used for general water supply, circulating, gathering, drainage, and other applications in the water utilities, paper, mining, petroleum, chemical and other industries. In addition to providing data on the pumps' construction features, the bulletin explains how to figure pumping head and carries tables of available sizes, approximate dimensions and head capacities. It also tabulates friction loss for water per 100 feet of pipe.

"Allis-Chalmers Motor and Generator Reference Book," 5147933, is designed to assist in the selection of motive power to handle most industrial applications. It is reprinted from the 1952 edition of Lincoln's "Industrial-Commercial Electrical Reference" published by the Electrical Modernization Bureau, Inc.

*Circle No. 18 on Postcard*

### Unique Slurry Washer

A combination agitating and filtering unit has been designed by Multi-Metal Wire Cloth Company, Inc., to give the required degree of washing to produce a slurry forming a fluffy filter cake consisting of 30 percent air, 20 percent solid and 50 percent liquid.

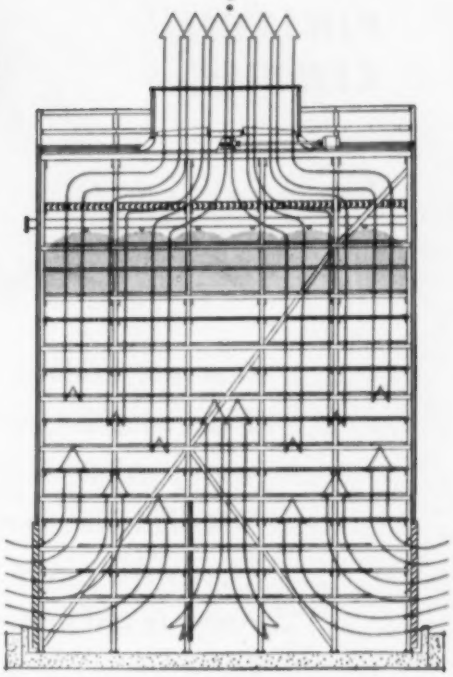
The unit is housed in a stainless steel tank, 56 inches tall and 28 inches in diameter. Inside is a filter basket consisting of metal filter cloth supported by a heavy backing screen, both held together top and bottom by expansion rings. An agitator with blades is mounted on a hollow center pipe which is for the admission of water. The edges of the blades clear the basket wall by less than ½ inch. Discharge is through a v-shaped valve in the conical bottom of the tank. The basket also has a conical bottom.

The purpose of the agitator is to keep the slurry in constant motion. To do this, the blades are pitched so as to lift the slurry constantly and scrape the filter cake off the inside wall of the filter

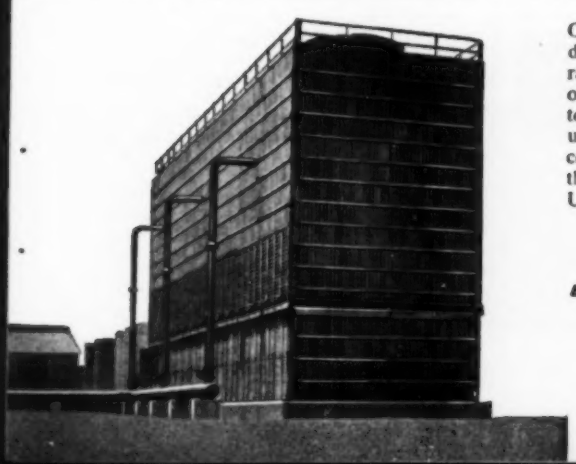
# *Efficiency of FLUOR COUNTERFLO Cooling Towers begins at the top*

Heavy stainless steel fan blades are finely balanced, resist corrosion and are mounted on shafts whose exceptionally high fatigue strength has been substantiated by strain gauge tests and actual use. Pitch is adjustable to efficiently handle required air volumes at minimum tip speeds and horsepower requirements – more air per kilowatt. Speed reducers incorporating spiral bevel gears feature oil-bath lubrication and dry-air breather. The low-speed fan shaft is mounted on special steep angle thrust with radial bearings to take the combined gear thrust, fan thrust and weight of fan assembly. Driving mechanisms are built for hard-wearing, maintenance-free performance and for smooth, quiet operation.

Vibration Cut-out switches, exclusive with Fluor Cooling Towers, are an emergency safety device that stops the motor should excessive vibration accidentally occur, preventing possible damage to the tower or mechanical equipment. Design employing internal gusset plates duplicates that used in wooden bridge construction. These connectors add greater tensile and compressive strength to structural members, lower the total weight of towers, require less erection time and materially increase tower life. Sloping grid decks of rough-finished redwood with minimum one-inch dimension are used as scaffolding during erection and provide maximum deck surface with negligible air pressure drop through the tower.



Air distribution is controlled at every stage of its travel through the tower. Louver height is designed to obtain the desired intake velocity and wind-deflectors inside the tower uniformly direct air currents to all areas. Approach to the desired wet-bulb temperature is easily accomplished and performance to customer's specifications is guaranteed in every case.



Only Fluor Counterflo Cooling Towers are completely prefabricated. All cutting, drilling, and nailing is performed at the factory and tower parts are "packaged" for rapid delivery, marked for orderly assembly. More efficient control of the quality of straight-grained heart of California redwood and excellent workmanship in Fluor towers are maintained through prefabrication. Inexperienced craftsmen and laborers under Fluor's supervision can erect a Fluor tower in a minimum of time and at considerable savings in erection costs. Prefabrication means standardization; parts that may become worn or damaged over the years may be replaced economically. Uniformity of appearance as well as performance is assured.

BE SURE WITH **FLUOR**

THE FLUOR CORPORATION, LTD.
LOS ANGELES 22, CALIFORNIA

FOREIGN: FACTS-FLUOR · PARIS
FLUOR OF CANADA · TORONTO
FLUOR INTERNATIONAL · BEIRUT
MEAD WRIGHTSON · LONDON

ENGINEERS
CONSTRUCTORS
MANUFACTURERS

NEW YORK
CHICAGO
BOSTON
PITTSBURGH
SAN FRANCISCO
HOUSTON
BIRMINGHAM
TULSA

# Quik-Set

a NEW
INSULATING
FINISHING
CEMENT

- One coat insulates and finishes
- Super-adhesion; no wire mesh
- Least possible shrinkage; no cracks
- Smooth, white, extra-hard finish
- Sets quickly . . . in two hours
- Apply to flat or complex surfaces
- For temperatures up to 1800°F!
- Paint with water or oil base paints
- Apply Quik-Set now; permanently weathercoat anytime later!

*Use this coupon today!*

**FORTY-EIGHT INSULATIONS, Inc.**
Telephone: Aurora 9207
AURORA, ILLINOIS

*Send me full details on Quik-Set*

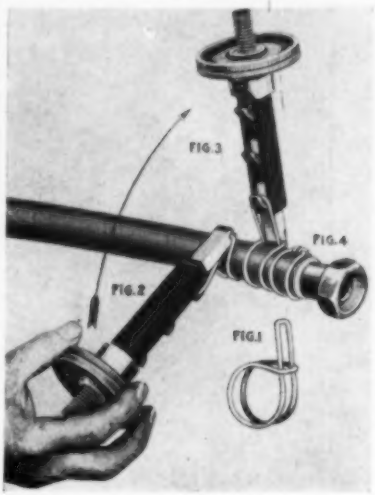
NAME _____
TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____


## *New Equipment . . .*

basket. Thus a minimum thickness of cake is left on the filter medium, insuring rapid flow and maximum drainage through the basket.

Since the agitator is nearly six feet long, a bottom bearing is provided to avoid possibility of whip. But since the dump valve is at the bottom of the tank, this bearing is constantly immersed in slurry having a high percentage of nitric acid. The bearing has a sleeve of lignum-vital as the bearing surface for the shaft and plug.

*Circle No. 19 on Postcard*




### New Hose Connection

The new type Squire-Cogswell hose connection is designed to save time and labor cost over the old method of applying couplings. The connection is comprised of a hose band and hose tool.

No bench or vise is needed to apply the bands; they may be attached anywhere. The tools are made in two sizes to fit all hoses; the Junior for bands up to ¾-inch sizes, and the Senior for bands of 1-inch size or over.

The bands are of soft steel wire, electro galvanized and welded. They are also available in brass if required. Available for hoses from ¼ to 3 inches in diameter, the bands can be used equally well for air, steam, water or oil hoses. The bands make a small joint, with no shoulder to catch or foul when moving the hose from place to place.

*Circle No. 20 on Postcard*

### Consulting Services

The silver anniversary issue of *Consulting Services*, 1953, has been issued in a revised and enlarged 14th edition by the Association of Consulting Chemists and Chemical Engineers, Inc.

The 144-page book is divided into four sections, preceded by a foreword and a page entitled "How to Find Your Consultant."

Section I contains about 200 items of activity, with the members specializing or qualifying in the given field indicated by key numbers. Section II describes each member's qualifications and activities. The new Section III gives information on rare equipment owned by members, and Section IV is an index. The

# *anyway you* LOOK *at it!*

**PETRO - CHEM ISO - FLOW FURNACES**

## are most efficient by any comparison!

**maximum fuel efficiency**

low maintenance

low pressure drop

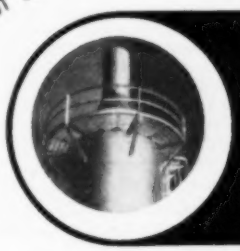
minimum ground space

better heat distribution

simplicity of design and construction

**The generic design of ISO-FLOW heaters, including the reradiating cone, gives excellent heat distribution, eliminating localized overheating. Further, all walls are protected by tubes which create low wall temperatures. The walls have high insulating characteristics which create minimum outside shell temperatures, and, hence, extremely low radiation. With a radiation loss of under 2%, more heat is absorbed by the fluid being heated, resulting in higher efficiency for any type of Iso-Flow design. Since Petro-Chem has a wide variety of convection sections, all heaters can be designed for optimum fuel efficiency or for maximum fuel efficiency where the price of fuel and other economic considerations justify.**

*More than 1100 are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petro-Chem Iso-Flow Furnaces are pre-eminently satisfactory.*



**PETRO-CHEM ISO-FLOW FURNACES**

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

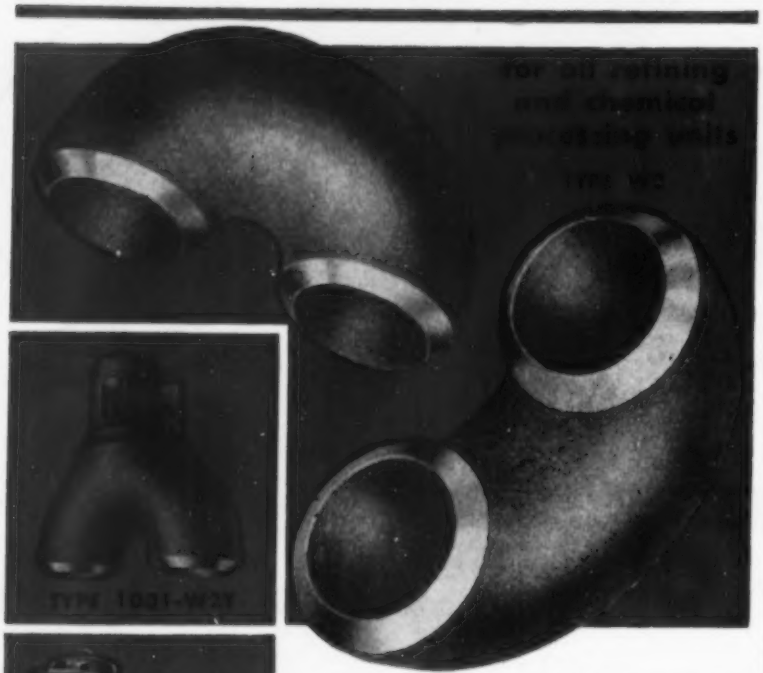
**PETRO-CHEM DEVELOPMENT CO., INCORPORATED**

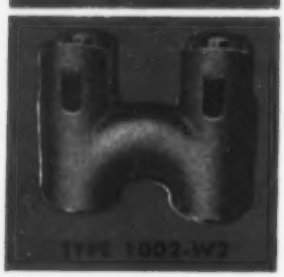
122 EAST 42ND STREET, NEW YORK 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston · Flagg, Brackett & Durgin, Boston · D. D. Foster, Pittsburgh · Faville-Levally, Chicago · Lester Oberholtz, California · Gordon D. Hardin, Louisville, Kentucky

# OHIO

## WELDING-TYPE FITTINGS





**CAST WELDABLES GIVE YOU:**

1. Lower cost
2. Longer life
3. Shorter centers
4. Heavier walls

**They can be furnished for all tube and pipe sizes, and I.D. and wall thickness; on close center dimensions; from any type of cast material.**

**IMPORTANT. In your specifications send us: I.D. of tube; O.D. of tube; operating conditions; inlet and outlet pressures and temperatures; center dimensions.**

**Three of the welding fittings shown here have cleanout or inspection openings equipped with Ohio Type 1000 closures. Other closures are available.**

**The Ohio Steel Foundry Company**

**LIMA, OHIO**

**PLANTS AT LIMA AND SPRINGFIELD, OHIO**


## *New Equipment . . .*

last section is arranged alphabetically by members, including names of organizations with which they are affiliated, and by geographical location, including branch offices, domestic as well as foreign.

*Circle No. 21 on Postcard*

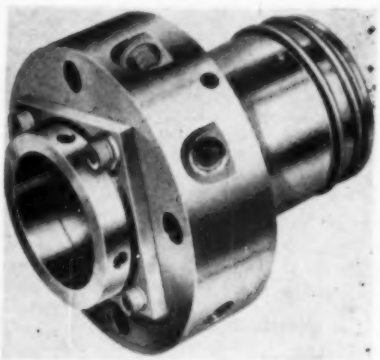
### New Pneumatic Transmitter

A miniature transmitter has been announced by The Bristol Company. The unit measures and transmits readings of temperature, pressure, vacuum, differential pressure and liquid level to recording, indicating and controlling receivers, including miniature type receivers. Transmission is by means of air pressures of between 3 and 15 psi that have a direct relation to the measured quantity.

Friction and lost motion are practically eliminated through use of standard Bristol measuring elements and a simple transmitting mechanism with only one pivot and no flexures. Known as the Bristol Series 650 Pneumatic Transmitter, it is sensitive to extremely small changes in the measured value, as little as 0.03 percent of range, including reversal.

The transmitter, weighing 7½ pounds, is weatherproof and can be installed in any location to operate in any position.

*Circle No. 22 on Postcard*



### Stuffing Box Seals

A new line of stuffing box seals for centrifugal pumps, Sealol Model SB seals, has been announced by Sealol Corporation. The stuffing box seals are pre-assembled, "packaged" units, ready for installation. Seal faces are protected against damage or contamination in storage or while being handled. No measurements are necessary to position the seal properly on the pump shaft, making installation simple.

Each design has been engineered for particular job requirements, with emphasis on ruggedness and durability. Special hard facings are available for maximum wear resistance at the point of the sealing.

*Circle No. 23 on Postcard*

See index page 204

ATLAS PROCESSING COMPANY at Shreveport, Louisiana, has recently placed in operation this Hudson-Built benzene recovery plant, the first to recover substantial quantities of natural benzene from liquid hydrocarbons extracted from natural gas. Over 98% of the benzene present in motor fuel base stocks produced in gas processing plants in the Carthage gas distillate field of East Texas is extracted in this unit. The benzene is nitration grade, having a purity of over 99.6%. Hudson is proud of its part in implementing the concept of the Atlas management in this pioneering operation.

**HUDSON**
**ENGINEERING CORPORATION**
**FAIRVIEW STATION • HOUSTON, TEXAS**

# New Equipment Literature

**Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the identifying key number of each item in which you are interested. Postcards are opposite page 192.**

AIR PREHEATERS—Details. The Air Preheater Corp. See page 25.
*Circle A1 on postcard.*

MECHANICAL STIRRUP AND DECK PLATFORM—Catalog. Albina Engine & Machine Works, Inc. See page 256.
*Circle A3 on postcard.*

REFINERY TYPE PROCESS PUMPS—Bulletin 52B7775. Allis-Chalmers Manufacturing Co. See pages 38-39.
*Circle A4 on postcard.*

CENTRIFUGAL BLOWERS—Information. Allis-Chalmers Manufacturing Co. See page 41.
*Circle A5 on postcard.*

CORROSION ENGINEERING SERVICE—Information. Alloy Steel Products Co. See page 4.
*Circle A6 on postcard.*

ALUMINUM PIPE, HEAT EXCHANGER TUBES, SHEET AND PLATE AND TANK CARS—Literature. Aluminum Company of America. See pages 188-189.
*Circle A7 on postcard.*

EXPANSION JOINTS—Bulletin 35-51A. American District Steam Co. See page 50.
*Circle A9 on postcard.*

ADSORBENTS, SORPTIVE MINERALS AND DESICCANTS—Information. Attapulgus Minerals & Chemicals Corp. See page 46.
*Circle B5 on postcard.*

PUMPS—Catalog "M." Aurora Pump Co. See page 278.
*Circle B6 on postcard.*

ALLOY TUBING—Bulletin TB-12. The Babcock & Wilcox Co. See page 207.
*Circle B7 on postcard.*

SWING JOINTS—Catalog No. 400. Barco Manufacturing Co. See page 250.
*Circle B10 on postcard.*

CAST STEEL FITTINGS—Catalog. The J. B. Beaird Co. See Insert 112-113.
*Circle C1 on postcard.*

WATER CONDITIONING—Technical Paper No. 125. W. H. & L. D. Betz. See page 249.
*Circle C3 on postcard.*

VENT VALVE FLAME ARRESTORS—Bulletin E-601. Black, Sivalls & Bryson, Inc. See page 237.
*Circle C5 on postcard.*

STEEL GRATING—Bulletin 2365. Blaw-Knox Co. See page 283.
*Circle C8 on postcard.*

PNEUMATIC TRANSMITTERS — Bulletin No. A105. The Bristol Co. See page 16.
*Circle C10 on postcard.*

SECTIONAL HEAT EXCHANGERS — Bulletin No. 512. The Brown Fintube Co. See page 236.
*Circle D1 on postcard.*

DRAGSHOVEL—Literature. Bucyrus-Erie Co. See page 235.
*Circle D2 on postcard.*

GAS ENGINE DRIVEN COMPRESSOR—Bulletin 130. Clark Bros Co. See pages 12-13.
*Circle D7 on postcard.*

FORK TRUCKS—Information. Clark Equipment Co. See page 245.
*Circle D8 on postcard.*

PRESSURE REDUCING AND REGULATING VALVES—Information. The Clark Manufacturing Co. See page 198.
*Circle D9 on postcard.*

TANK SUCTION HEATERS—Literature. Davis Engineering Corp. See page 224.
*Circle E5 on postcard.*

SYNTHETIC FLUID-TYPE CRACKING CATALYST—Information. The Davison Chemical Corp. See pages 242-243.
*Circle E6 on postcard.*

STEAM TURBINES—Information and Specifications. Dean Hill Pump Co. See page 65.
*Circle E8 on postcard.*

ROTARY PUMPS—Bulletin LG. De Laval Steam Turbine Co. See page 47.
*Circle E9 on postcard.*

STEAM LINE CORROSION TREATMENTS—Technical Bulletins. E. F. Drew & Co., Inc. See page 205.
*Circle F3 on postcard.*

WEED KILLER—Booklet. E. I. du Pont de Nemours & Co. See page 33.
*Circle F4 on postcard.*

FUEL OIL ADDITIVE—Bulletin A-5201. E. I. du Pont de Nemours & Co. See Insert 224-225.
*Circle F6 on postcard.*

CUTTER HEADS—Information. Elliott Co. See page 23.
*Circle F9 on postcard.*

OUTDOOR SPLASHPROOF MOTOR—Information. Elliott Co. See page 92.
*Circle F10 on postcard.*

POWER INDUSTRIAL TRUCKS—Catalog. The Elwell-Parker Electric Co. See page opp. 96.
*Circle G2 on postcard.*

PRESSURE AND LIQUID LEVEL CONTROLS—Bulletin F-2506. Fisher Governor Co. See page 14.
*Circle G4 on postcard.*

ADSORBENTS, DESICCANTS AND DILUENTS—Information. Floridin Co. See page 190.
*Circle G6 on postcard.*

INSULATING FINISHING CEMENT — Details. Forty-Eight Insulations, Inc. See page 200.
*Circle G8 on postcard.*

FLOW CONTROLLER—Bulletin 470. The Foxboro Co. See pages 60-61.
*Circle G9 on postcard.*

PACKINGS AND GASKETS—Catalog. The Garlock Packing Co. See page 87.
*Circle G10 on postcard.*

INSULATED WIRE—Information. Claud S. Gordon Co. See page 284.
*Circle H2 on postcard.*

CASTABLE REFRACTORIES—Information. A. P. Green Fire Brick Co. See page 75.
*Circle H4 on postcard.*

CONSTANT SUPPORT HANGER—Catalog. Grinnell Co., Inc. See page 67.
*Circle H5 on postcard.*

AIR-COOLED HEAT EXCHANGER — Details. Griscom-Russell Co. See page 42.
*Circle H6 on postcard.*

CONCRETE CONSTRUCTION — Specifications and Bulletins, Gunite Concrete and Construction Co. See page 280.
*Circle H7 on postcard.*

CORROSION INHIBITOR—Information. D. W. Haering & Co., Inc. See page 272.
*Circle H8 on postcard.*

JACKETED PIPE AND FLUIDOMETER SYSTEMS—Bulletin F1-49. Hetherington & Berner, Inc. See page 283.
*Circle J1 on postcard.*

METERING AND PROPORTIONING PUMPS—Catalog and Pump Selection Manual. Hills-McCanna Co. See page 218.
*Circle J2 on postcard.*

MIXERS—Bulletins. International Engineering, Inc. See page 206.
*Circle J7 on postcard.*

WIRE-MESH PRODUCTS—Details. The C. O. Jelliff Mfg. Co. See page 279.
*Circle J9 on postcard.*

GAGES AND VALVES—Data Units. Jerguson Gage & Valve Co. See page 221.
*Circle J10 on postcard.*

ASBESTOS CORRUGATED—Information. Keasbey & Mattison Co. See page 110.
*Circle K1 on postcard.*

INERT GAS GENERATORS—Facts and Technical Information. The C. M. Kemp Manufacturing Co. See page 82.
*Circle K3 on postcard.*

VACUUM PUMPS—Bulletin V-51B. Kinney Manufacturing Co. See page 281.
*Circle K7 on postcard.*

FRACTIONATING TRAYS — Information. Koch Engineering Co. See III Cover.
*Circle K8 on postcard.*

GASOLINE ANTIOXIDANT—Information. Koppers Co. See page 273.
*Circle K9 on postcard.*

WELL WATER SUPPLY OR PUMP EQUIPMENT—Information. Layne & Bowler, Inc. See page 101.
*Circle L1 on postcard.*

RECORDERS AND CONTROLLERS — Catalog ND46(1) and Technical Publication ND46(1). Leeds & Northrup Co. See page 8.
*Circle L2 on postcard.*

STAINLESS STEEL PRODUCTS — Information. Lukens Steel Co. See page 66.
*Circle L4 on postcard.*

SAFETY RELIEF VALVES—Information. Manning, Maxwell & Moore, Inc. See page 48.
*Circle L8 on postcard.*

CENTRIFUGAL PUMPS—Oil Country Bulletin. Marlow Pumps. See page 275.
*Circle L9 on postcard.*

MIST ELIMINATORS—Bulletins. Metal Textile Corp. See page 94.
*Circle M4 on postcard.*

CONTROLLED VOLUME PUMPS—Bulletin 351. Milton Roy Co. See page 54.
*Circle M5 on postcard.*

AROMATIC HYDROCARBON DETECTOR—Bulletin No. DD-1. Mine Safety Appliances Co. See page 264.
*Circle M6 on postcard*

CENTRALIZED GRAPHIC INSTRUMENTATION — Bulletin 85-20. Minneapolis-Honeywell Regulator Co. See pages 36-37.
*Circle M7 on postcard.*

MIXERS—Catalogs. Mixing Equipment Co. See page 88.
*Circle M8 on postcard.*

INSTRUMENT TUBING—Bulletin L-6506. Samuel Moore & Co. See page 260.
*Circle M9 on postcard.*

STEAM TURBINES—Information. Murray Iron Works Co. See page 282.
*Circle M10 on postcard.*

FUEL OIL-GAS BURNERS — Information. National Airoil Burner Co. See page 284.
*Circle N1 on postcard.*

FOAM FIRE PROTECTION—Magazine. National Foam System, Inc. See page 69.
*Circle N3 on postcard.*

STEAM TRAPS—Catalog 751. W. H. Nicholson & Co. See page 282.
*Circle N5 on postcard.*

PORUS MEDIUMS—Information. Norton Co. See page 28.
*Circle N7 on postcard.*

TOWER CLEANING PROCESS — Information. Oakite Products, Inc. See page 262.
*Circle N8 on postcard.*

REFINERY PUMPS—Information. Oil Well Supply Division, United States Steel Corp. See page 5.
*Circle N10 on postcard.*

VALVES—Bulletin No. 51FL. Okadee Co. See page 254.
*Circle P1 on postcard.*

WEED KILLER—Literature. Pacific Coast Borax Co. See page 274.
*Circle P3 on postcard.*

PUMPS—Bulletins. Peerless Pump Division. Food Machinery & Chemical Corp. See page 29.
*Circle P4 on postcard.*

FLEXIBLE TUBING—Folder. Pennsylvania Flexible Metallic Tubing Co. See page 59.
*Circle P5 on postcard.*

TANK SWITCHING — Booklet. Petrolite Corp. See page 83.
*Circle P7 on postcard.*

LECTRODRYERS—Information. Pittsburgh Lectrodryer Corp. See page 85.
*Circle P10 on postcard.*

HEATING AND COOLING PROCESS COILS—Bulletin P78. Platecoil Division, Kold-Hold Manufacturing Co. See page 214.
*Circle Q1 on postcard.*

PROCESSING AND HEAT TREATING EQUIPMENT—Catalog 52. The Pressed Steel Co. See page 32.
*Circle Q4 on postcard.*

CHEMICAL FEEDERS AND DIATOMITE FILTERS—Bulletin RP-9373. %Proportioneers, Inc.% See II Cover.
*Circle Q6 on postcard.*

AIR FOAM EQUIPMENT—Information. Pyrene Manufacturing Co. See page 246.
*Circle Q7 on postcard.*

VALVES—Information. R-S Products Corp. See page 219.
*Circle Q8 on postcard.*

CONCRETE PIPE STANCHIONS — Literature. The George Rackle & Sons Co. See page 266.
*Circle Q9 on postcard.*

REFINERY CATALOGING INFORMATION—Literature. The Refinery Catalog. See page 51.
*Circle R1 on postcard.*

REFINERY CONSTRUCTION — Brochure. The Refinery Engineering Co. See pages 76-77.
*Circle R2 on postcard.*

ELECTRIC WELDED BOILER TUBES—Booklet. Republic Steel Corp. See page 31.
*Circle R3 on postcard.*

STAINLESS STEEL—Information. Republic Steel Corp. See page 288.
*Circle R4 on postcard.*

CORROSION-RESISTANT DIAL THERMOMETERS — Information. Rochester Manufacturing Co. See page 257.
*Circle R7 on postcard.*

BALL VALVES—Folder V-4. Rockwood Sprinkler Co. See page 227.
*Circle R10 on postcard.*

POSITIVE DISPLACEMENT METERS—Bulletin M-152. Roots-Connersville Blower Corp. See page 230.
*Circle S1 on postcard.*

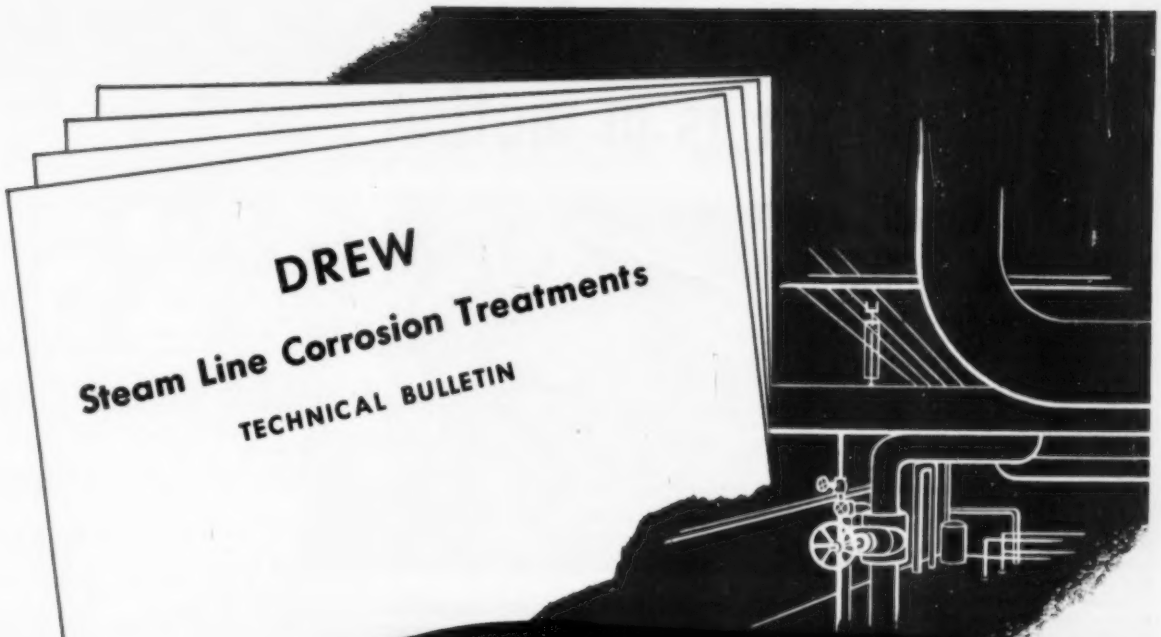
THERMOSTATIC STEAM TRAPS—Catalog 256. Sarco Co., Inc. See page 34.
*Circle S2 on postcard.*

REFRACTORY PROBLEMS—Details. Schapansky and King. See page 264.
*Circle S3 on postcard.*

HEAT EXCHANGER TUBES — Booklet. Scovill Manufacturing Co. See page 238.
*Circle S4 on postcard.*

MECHANICAL SEALS FOR PROCESS PUMPS—Information. Sealol Corp. See page 277.
*Circle S5 on postcard.*

**More Listings on Page 206**




# DREW STEAM LINE CORROSION CONTROL TREATMENTS ELIMINATE STEAM AND CONDENSATE LINE REPLACEMENTS

A leading food plant was constantly replacing condensate return lines that had failed. Drew Engineers determined the cause of failures to be carbon dioxide in the condensate.

For treatment, Drew SLCC was recommended. This is a non-toxic material which does not taint the food being processed in the plant. A volatile alkali, Drew SLCC corrected the condition quickly by neutralizing the carbon dioxide. In this plant, Drew treatment put an abrupt end to costly maintenance.

In other instances of steam and condensate line corrosion, Drew Products such as SLCC-Q and SLCC-A are used, depending upon conditions. To prevent or eliminate water problems in your plant, you'll get results faster and more economically with the Drew 5-point program

1. Thorough study and analysis of the problem
2. Use of effective organic and inorganic materials
3. Efficient methods of feeding materials to the system
4. Control of dosages by simplified plant testing
5. Qualified field supervision and technical assistance

*Write for technical bulletins.*

*Power Chemicals Division*

**E. F. DREW & CO., INC.**

**15 East 26th Street, New York 10, N. Y.**

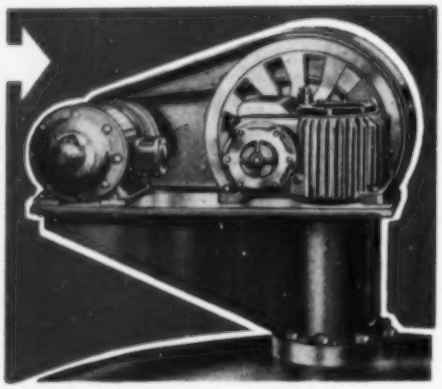
SAN FRANCISCO CHICAGO PHILADELPHIA BOSTON DALLAS ASHEVILLE, N. C.
AJAX, ONTARIO

***Service throughout the United States, Canada and South America***

**DREW PRODUCTS**

# Now you can Change Speed while Mixer is in motion

## "International" TYPE "LRV" MIXER

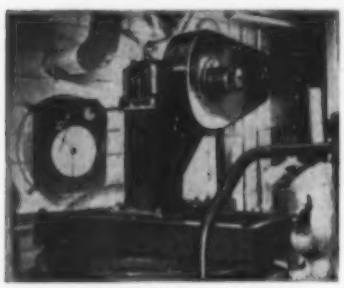


**Here is a brand New Design, Variable-Speed Agitator Driving Unit—selling at a really down to earth, rock bottom price.**

**The speed of this unit can be changed while in motion. The capital investment for such a profitable plant improvement is relatively small.**

**Speed variance as high as 5 to 1 (single speed motor) with any desired speed within the above speed change range. When these units are equipped with vari-speed motor instead of the standard single speed motor an almost infinite range of speeds can be attained in a few seconds.**

**Speed change accomplished by simply rotating speed change knob. No gears or belts to change.**



**"International" Type LRV Mixer**

**Above photo shows installation in plant where it is desirable to be able to change shaft speed while Mixer is in full operation.**

**NO WORK STOPPAGE WHILE CHANGING SPEED—NO GEARS OR BELTS TO CHANGE —NO TIME LOST IN GETTING PROPER SHAFT SPEED FOR BEST RESULTS . . .**

**"International" Simplified Designs and standardized production Guarantee you advantages of the most expensive equipment at much lower prices.**

**These Mixers are adaptable to viscosity or material change while batch is being mixed; particularly useful where various viscosity materials may be mixed in the same vessel.**

**Units can be readily changed from one vessel to another. Mixers are package units aligned and assembled in our factory—ready to mount on your vessel and ready to operate. Mixers are designed for closed or open vessel—"LRV" for closed—"LRVA" for open tanks.**

**Let our Engineering Department show you, without obligation, how you can now make important equipment improvements with minimum outlay—REMEMBER, International Processing Equipment must be satisfactory or your money back.**

## INTERNATIONAL TYPE "LRB" MIXER

*(Illustrated Below)*

**For Refinery applications where Speed need not be changed while Mixer is in operation . . .**

**Type "LRB" Speed changes are obtained by means of sheave substitution with standard stock taper hubs and adjustment of belt tension which requires only a few minutes of operator's time.**

**20 A.G.M.A. speeds from 420 rpm down to 9 rpm are available and each set up is interchangeable over an approximate 3½ to 1 speed range.**

**Mixers are process engineered—factory assembled—ready to operate when uncrated—and at rock bottom low cost. Arranged for closed or open tanks.**

**Bulletins and full information on request.**

**INTERNATIONAL ENGINEERING, INC.**
**DAYTON 1, OHIO**

NEW YORK
15 PARK ROW
WOrth 2-2580

CHICAGO
407 S. DEARBORN ST.
WAbash 2-0733

*Put your processing problems up to*
**"International"**
*LEADING MFRS. OF REFINERY EQUIPMENT*


## [ Equipment Literature ]

FLUID PROCESSING OF AIR, GAS AND LIQUIDS—Details. Selas Corporation of America. See page 253.
*Circle S6 on postcard.*

DISTILLATION TRAYS—Information. Shell Development Co. See page 81.
*Circle S7 on postcard.*

FINISH SELECTION GUIDE—Brochure A-770. The Sherwin-Williams Co. See page 248.
*Circle S8 on postcard.*

PUMP VALVES—Catalog. Sims Pump Valve Co. See page 266.
*Circle S9 on postcard.*

PUMPS—Information. Southern Engine & Pump Co. See page 279.
*Circle T2 on postcard.*

REGULATING VALVES—Catalog 68-X. Strong, Carlisle & Hammond Co. See page 264.
*Circle T4 on postcard.*

PROCESS CONTROL INSTRUMENTS — Information. Taylor Instrument Companies. See pages 258-259.
*Circle T8 on postcard.*

AUTOMATIC DATA REDUCTION — Technical Bulletin 105. Telecomputing Corp. See page 55.
*Circle T9 on postcard.*

STEAM TURBINES—Bulletin S-116. The Terry Steam Turbine Co. See page 71.
*Circle T10 on postcard.*

RADIOACTIVITY AND THE PETROLEUM INDUSTRY—Pamphlet. Tracerlab Inc. See page 268.
*Circle U3 on postcard.*

VALVE DISCS—Details. Tri-State Mfg. & Engr. Co. See page 266.
*Circle U4 on postcard.*

ELECTRIC WIRES AND CABLES — Brochure. United States Rubber Co. See page 195.
*Circle U5 on postcard.*

INDUSTRIAL PLASTICS—Bulletin and Specifications. The Van Dorn Iron Works Co. See page 262.
*Circle U9 on postcard.*

ALLOY STUDS AND BOLTS—Catalog. Victor Products Corp. See page 267.
*Circle U10 on postcard.*

TWO-DRUM STEAM GENERATORS—Bulletin. Henry Vogt Machine Co. See page 186.
*Circle V1 on postcard.*

CHLORINATION EQUIPMENT — Information. Wallace & Tiernan Products, Inc. See page 252.
*Circle V3 on postcard.*

GATE VALVES—Information. Walworth Co. See page 52.
*Circle V4 on postcard.*

STEEL VALVES—Catalog No. 52-12-W. Wedge-plug Valve Co. See page 96.
*Circle V8 on postcard.*

METAL THERMOMETERS—Literature. Weston Electrical Instrument Corp. See page 226.
*Circle V9 on postcard.*

TUBE EXPANDERS—Bulletin No. 71. The Gustav Wiedeke Co. See page 280.
*Circle X1 on postcard.*

CHECK VALVES—Bulletin WH-851. Williams Gauge Co. See page 210.
*Circle X2 on postcard.*

CENTRIFUGAL PUMPS — Bulletin W300-B-4. Worthington Corp. See page 10.
*Circle X5 on postcard.*

AIR COMPRESSORS—Bulletin L-675-B1B. Worthington Corp. See page 11.
*Circle X6 on postcard.*

## Kellogg Initiates New Plan For Employes Scholarships

Salaried employes will have an opportunity to obtain full tuition grants for undergraduate and graduate work while maintaining their regular base pay under The M. W. Kellogg Company's new industrial scholarship plan. The company announced that the Morris W. Kellogg Scholarships, named for the founder of the company who died in 1952, consist of one grant for the pursuance of a master's degree and two for a bachelor's degree each year.

The scholarships will be offered annually to selected salaried employes of the company and its subsidiaries.

## Husky Gives Lee Canadian Post

Lawrence W. Lee, formerly a vice president of Husky Oil Company, is scheduled to become executive vice president of the company's Canadian subsidiary, Husky Oil & Refining, Ltd. He remains on the Husky's board of directors.

# take a CLOSER LOOK at B&W ALLOY TUBING for high temperature applications

CARBON-MOLY • CROLOY ½ • CROLOY 1¼
CROLOY 2 • CROLOY 2¼ • CROLOY 3-M • CROLOY 5
CROLOY 5-SI • CROLOY 7 • CROLOY 9-M

**All of these intermediate alloys, developed for oil refinery service, are being used extensively in a wide variety of high temperature applications. All have earned universal acceptance and praise for giving optimum service satisfaction with economy over the years. The accompanying table shows the extensive range of temperature, pressure, corrosion, and oxidation conditions met by B&W Alloy Tubing. Technical data on these analyses is contained in Bulletin TB-12, available upon request. Call on Mr. Tubes—your B&W Tube Representative—to get the benefit of the extensive tubing service he represents, on your specific petroleum processing applications.**

**CARBON-MOLY** —0.50% Mo—For services to 1050F requiring higher creep strength than carbon steel with no increase in corrosion or oxidation resistance.

**CROLOY ½** —0.60% Cr, 0.50% Mo—For operating conditions to 1075F requiring properties superior to carbon-moly with respect to graphitization and creep strength.

**CROLOY 1¼** —1.25% Cr, 0.50% Mo, 0.75% Si—Economic grade good creep strength properties up to 1100F. Somewhat more corrosion resistant than chromium-free steels.

**CROLOY 2** —2% Cr, 0.50% Mo—Economic grade for resisting both oxidation and corrosion, with excellent high-temperature strength, up to 1150F.

**CROLOY 2¼** —2.25% Cr, 1.00% Mo — Exceptionally high creep strength up to 1175F for polymerization and high pressure cracking. Otherwise similar in properties and characteristics to Croloy 2.

**CROLOY 3-M** —3% Cr, 0.90% Mo — Somewhat better creep properties, and resistance to corrosion and oxidation up to 1175F than Croloy 2.

**CROLOY 5** —5% Cr, 0.50% Mo—For operating conditions up to 1200F where corrosion resistance is a primary requirement—with creep strength and oxidation resistance superior to Croloy 2.

**CROLOY 5-Si** —5% Cr, 0.50% Mo, 1.50% Si—For operating conditions up to 1300F where oxidation resistance is a primary requirement. Excellent resistance to scaling under straight oxidizing conditions.

**CROLOY 7** — 7% Cr, 0.50% Mo, 0.50-1.00% Si — For operating conditions up to 1250F where corrosion resistance is the primary requirement. Somewhat more oxidation resistant than Croloy 5.

**CROLOY 9-M** —9% Cr, 1% Mo—For severe operating conditions up to 1300F where high corrosion and oxidation resistance are essential as in hydrogenation processes.

Steels from CROLOY 1¼ upward are electric furnace alloy steels which are normally cleaner and of better quality than open hearth steels. This contributes to greater reliability and improved creep properties at elevated temperatures.

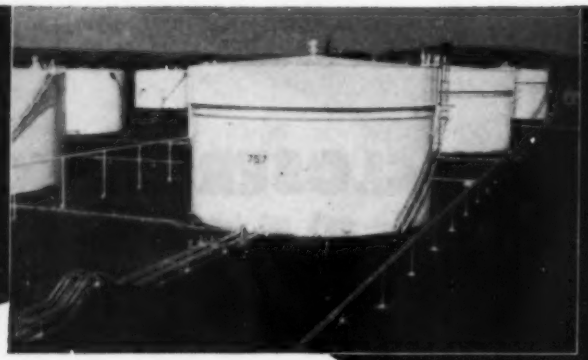
B&W SEAMLESS and WELDED TUBES

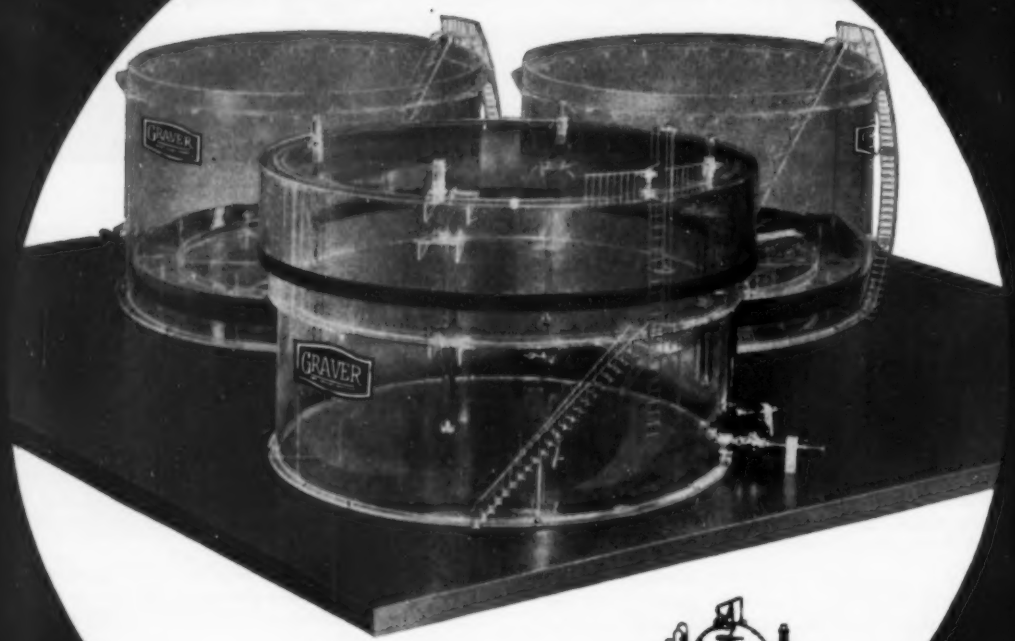
**THE BABCOCK & WILCOX COMPANY**
**TUBULAR PRODUCTS DIVISION**
**General Offices & Plants**
**Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing**
**Alliance, Ohio—Welded Carbon Steel Tubing**

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. Cleveland 14, Ohio • Denver 1, Colo. • Detroit 26, Mich. • Houston 19, Texas Los Angeles 17, Cal. • New York 16, N. Y. • Philadelphia 2, Pa. St. Louis 1, Mo. • San Francisco 3, Cal. • Syracuse 2, N. Y. Toronto, Ontario • Tulsa 3, Okla.

TA-1685

CONSERVATION
*DEMONSTRATED!*






INTERNATIONAL PETROLEUM EXPOSITION
TULSA MAY 14-23

GRAVER

**You are cordially invited to**

view the Graver Expansion Roof Tank and the Graver Floating Roof Tanks as seen in Scale Working Models hand-crafted in plastic.

These highly visual models demonstrate dramatically the vapor-saving and gasoline-saving potentialities inherent in these patented designs.

Graver Floating Roof Tanks are equally suitable —and widely used-for the storage of crudes. The roof, floating directly upon the crude, allows no air pockets, thus minimizing corrosion.

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA
NEW YORK • CHICAGO • PHILADELPHIA • ATLANTA
DETROIT • CLEVELAND • PITTSBURGH • HOUSTON
CATASAUQUA, PA. • SAND SPRINGS, OKLA. • CASPER, WYO.

Conducted by
**Al Reese,** Special Assignments Editor

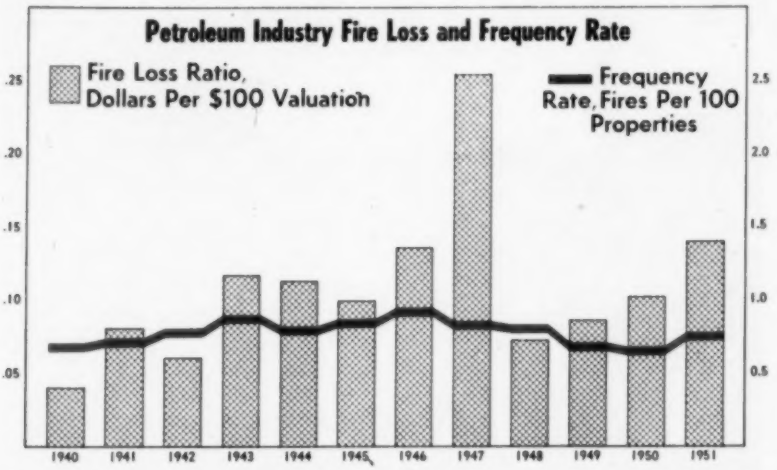



**Figure 1. The oil industry's fire record is good. In the most recent 12-year period for which complete figures are available, the frequency rate has not exceeded one fire per 100 properties annually as is shown by the solid line on the chart. The fire loss ratio, with the exception of 1947, the year of the severe damage at Texas City, Texas, where fires on petroleum properties were the result of a freighter explosion at a nearby dock, has been less than 15 cents per $100 valuation as is shown by the bars. (Source—American Petroleum Institute.)**

# Industry Should Boast Of Great Fire Record

## Spectacular oil fires give public wrong idea of danger to outside installations

**Franklin G. Wilson,** Director,
Safety & Fire Protection Service,
American Petroleum Institute, New York

THE PETROLEUM industry has an enviable fire record, but unfortunately too little of its fire protection methods are known or understood by outsiders. Anything that can be done to create confidence in the fire prevention activities of oil companies, and to relieve fears of the public and public officials concerning the industry's fire protection methods, will work to mutual advantage.

Petroleum's fire record proves that the industry is not a growing hazard and a constant threat to the community. The occasional fires on oil properties—seven fires per 1000 properties in 1951 and less than ten fires per 1000 properties annually in recent years as is shown in Figure 1—do not endanger the entire community because oil fires are not conflagration-breeders. There are no flying brands to carry fire over the heads of fire fighters, and while the spectacular clouds of smoke make an oil fire look ominous, those very clouds of smoke actually absorb the heat of burning gases and reduce exposure temperatures.

Sometimes it is better to control a fire and let it burn until the fuel supply can be shut off than it is to extinguish it. Such facts are not generally known outside the industry, and since oil fires always seem to make good newspaper copy, with such erroneous terms as "explosive" gasoline fire and spectacular photographs of massive columns of smoke, a fear psychology has been engendered in the public mind.

While a quarter of a century ago the industry's fire protection record was so poor that oil companies experienced great difficulty in getting insurance coverage of properties, in some areas today petroleum properties enjoy the lowest coverage rate of any industry. Considering the volatility and gaseous nature of the products handled, the fire record of the industry is unusually good. During 1951, the industry's ratio of outside fires which spread to oil property against oil fires which spread to other property was 7.5 to 1, indicating that the industry is at least able to cope with such fires as do occur on oil property.

Obviously, the most vulnerable spots within the industry are refineries—but even here the record is good; two fires per plant per year with a loss ratio of 15 cents per $100. A comparison of the ratio of fire loss to investment in refinery equipment over periods of ten years, 15 years and the 5-year period

**A simulated rack fire at the Avon plant (Associated, Calif.) where Tide Water Associated Oil Company trains its refinery personnel.**

STOP COSTLY WATER HAMMER NOW!

WILLIAMS-HAGER FLANGED Silent CHECK VALVES

Williams-Hager Flanged Silent Check Valves are the economical and dependable answer to troublesome and costly "water hammer" in all pump lines. These valves operate effectively in horizontal, vertical, upside down or angular positions—under any service or pressure condition.

WRITE FOR BULLETIN WH-851

This bulletin gives complete details on the cause, effect and control of damaging "Water Hammer." Use the coupon below for prompt delivery of your copy.

CHECK VALVES

THE WILLIAMS GAUGE CO., INC.

1640 Pennsylvania Ave. Pittsburgh 33, Pa.

MAIL THIS COUPON Today!

THE WILLIAMS GAUGE COMPANY
1640 Pennsylvania Avenue
Pittsburgh 33, Pa.

Please send a copy of Bulletin WH-851 on "Water Hammer, Cause, Effect and Control in Piping Systems."

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____


## As Management Sees It . . .

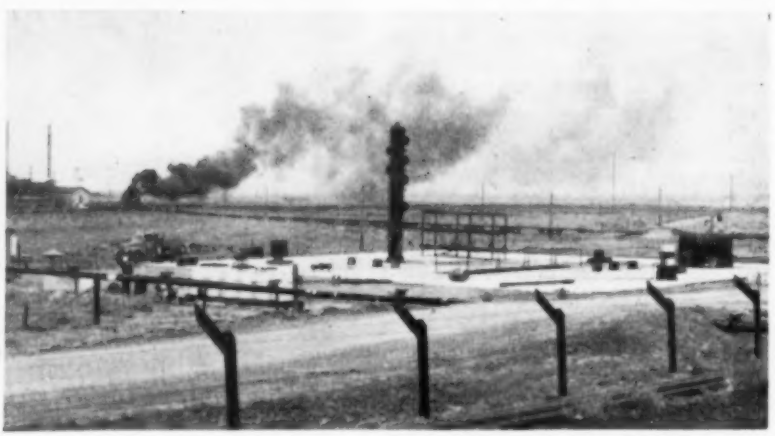
A pipe trench fire is being blanketed with fog to extinguish the fire by cooling the oil and smothering with steam at the Union Oil Company of California training grounds. Firemen in the picture are Los Angeles Fire Department personnel under training.

from 1946 to 1950, inclusive, is shown in Figure 2. It will be noted that whereas the average investment per plant is $15 million, the average fire loss per year per plant is only $23,000.

Fire protection in the petroleum industry means design, construction and operation of facilities planned in relationship to the ever-present hazard of accidental fires to life and property; the development and organization of fire control mechanisms and techniques and the training of employes in their use; an organized relationship between an industrial plant and the fire control and suppression forces of the community in which it is situated.

The petroleum industry recognizes its obligation to society to use reasonable care to prevent fires simply because of the wastefulness and danger of personal injury. Certainly it is more economical to safeguard against fire than it is to extinguish a fire after it occurs.

The fire protection engineer's primary function is to aid his company in the reduction of its fire loss. Basically, oil industry management intends that the fire protection program should



Tide Water Associated uses this "mock up" of various refinery equipment to train its personnel.

# name your refinery equipment needs

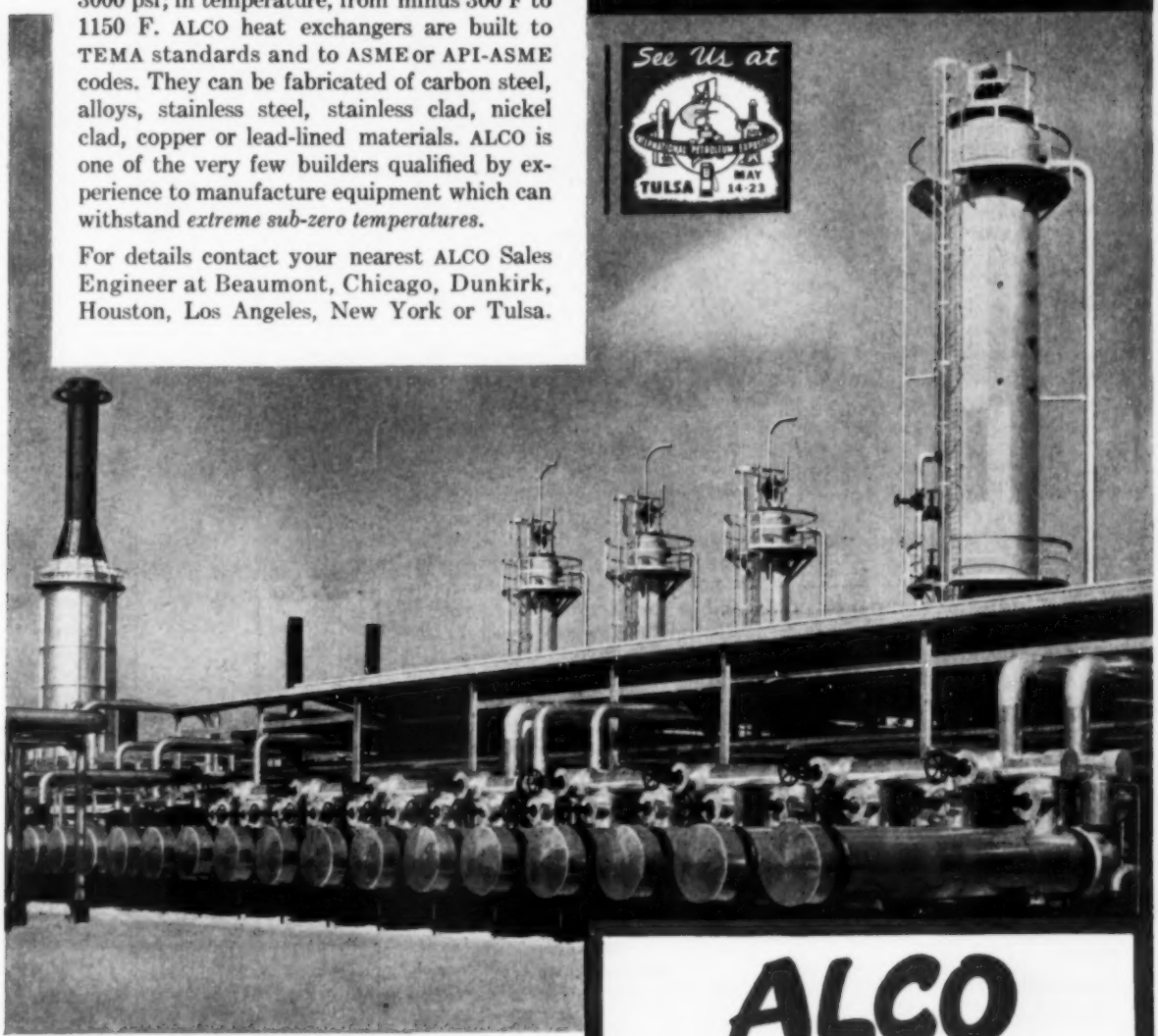
*Custom engineering* . . . that's the secret of ALCO's success at meeting virtually all of the refining industry's many equipment requirements.

Rugged ALCO products have been produced to cover an extremely wide range of requirements. Units vary in diameter from four inches to twelve feet; in weight, from 100 to 300,000 pounds; in pressure, from high vacuum to 3000 psi; in temperature, from minus 300 F to 1150 F. ALCO heat exchangers are built to TEMA standards and to ASME or API-ASME codes. They can be fabricated of carbon steel, alloys, stainless steel, stainless clad, nickel clad, copper or lead-lined materials. ALCO is one of the very few builders qualified by experience to manufacture equipment which can withstand *extreme sub-zero temperatures.*

For details contact your nearest ALCO Sales Engineer at Beaumont, Chicago, Dunkirk, Houston, Los Angeles, New York or Tulsa.

*piping*
*pressure vessels*
*heat exchangers*
*product filters*

**ALCO can meet them**




**ALCO**

ALCO PRODUCTS DIVISION
AMERICAN LOCOMOTIVE COMPANY
Dunkirk, N. Y.

A one-man approach to a simulated gasoline pump fire behind a fog stream at the Union Oil Company of California fire school at Wilmington, California.

be conducted with the same objectives as any other company activity, namely to obtain for the funds expended the greatest possible return in improved public relations and tangible savings in decreased fire loss. In addition, management strives to achieve the natural economies which result from avoiding expenditures which yield little or no return, such as those promoted by uninformed or restrictive legislation.

### Work Within the Company

But more and more the oil companies insist that the fire protection staff must work within the company to assist operating departments to:

- Establish fundamental safety policies and organization.
- Inspect and recommend correction of unsafe conditions and procedures.
- Review plans for new operations.
- Develop and conduct training in fire prevention and extinguishment.
- Investigate fires and determine lessons learned from them.

This presupposes the compilation and maintenance of basic statistics; the provision and use of training aids; the dissemination of information on important oil industry fires; and capable assistance to management safety committees.

The accomplishment of these objectives will be more readily attained through close cooperation with organizations outside of the petroleum industry to effect the correction of unnecessarily restrictive regulations, and an exchange of fire experience and related factors. And if assistance is rendered to local authorities in the formulation and effectuation of plans for control of conflagrations, there should be a noticeable improvement of public relations with respect to the so-called oil industry fire hazards.

In the final analysis, the simplest approach to fire protection in any large industry may be found in the technique of instructing individuals in what could happen to them as a result of fire, and what they personally can do in their jobs to prevent and control fires.

It is recognized that this is definitely an emotional approach, but it can be justified psychologically on the broad

**FIGURE 2**
**Refinery Fire Record**

| | 10 Year | 15 Year | '46-'50 |
|---|---|---|---|
| **Fire Frequency Rate:** | | | |
| All Classes | 153.29 | 162.46 | 187.77 |
| Spread in | 0.44 | 0.91 | .... |
| Spread out | .... | 0.11 | .... |
| **Average Fire Loss:** | | | |
| Per year/plant | 6,003 | 10,867 | 23,249 |
| Ratio $/$100 | 0.103 | 0.134 | 0.153 |

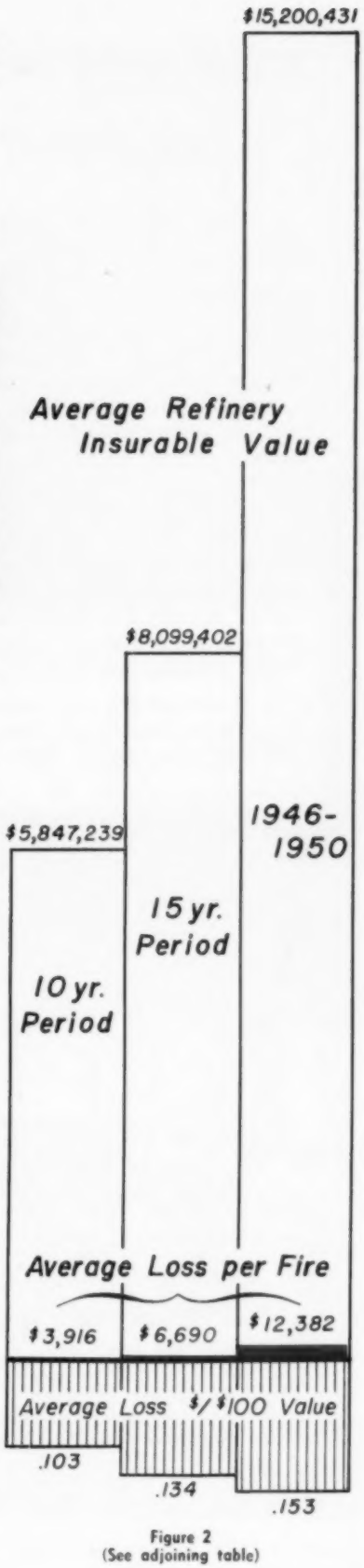



Figure 2
(See adjoining table)

# LATEST MODEL

## *Alkylation Unit for* SOHIO

THIS model of an alkylation unit was built from engineering drawings to a scale of ¼ inch to 1 foot. Its purpose is to help check engineering and speed up construction of a new alkylation unit designed and now being constructed by Arthur G. McKee & Company for Standard Oil Company of Ohio at Toledo.

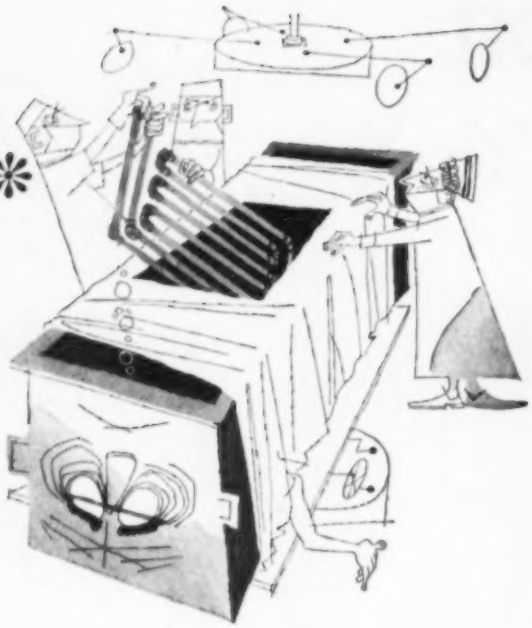
The Sohio project is one of four new alkylation units now in progress by the McKee organization. The others are located at Wood River, Illinois; Norco, Louisiana and Texas City, Texas. Combined capacity of the four units will be approximately 21,000 barrels of alkylate production per stream day.

**ENGINEERING, PURCHASING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES**

**Arthur G. McKee & Company • Established 1905**

*Headquarters:* McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio.
*Offices:* New York • Tulsa, Oklahoma • Union, New Jersey • Washington, D. C.
*British representatives of Metals Division:* Head, Wrightson & Company, Ltd.
*Canada:* **Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto 1, Ont.**

has
**coil-itis***
got you
constantly
doctoring
your
tanks?



Like the human appendix, pipe coils often give constant trouble until they are removed and replaced with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster. They take 50% less space in the tank leaving room for greater payload. Platecoils overcome the limitations and operating difficulties of old fashioned and outmoded pipe coils to save hours of downtime.

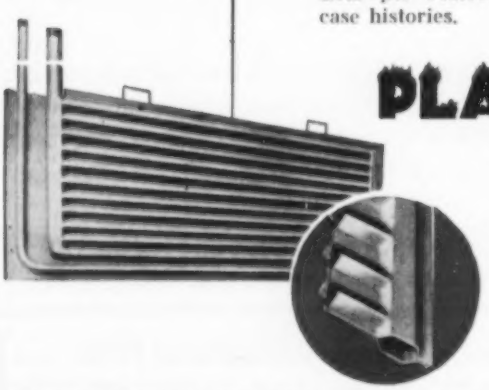
It costs less to cure coil-itis with Platecoils than to suffer its evils.

**Write for Bulletin P78 today!**

**PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS**

**PLATECOILS REQUIRE 90% LESS CLEANING**

At Motor Wheel Corporation cleaning time has been cut from 10 hours per pipe coil every 60 days to only one hour per Platecoil. Ask about other case histories.



**PLATECOIL**

**REPLACES PIPE COILS**

*Coil-itis — Diagnosed as tank heating and cooling problems. **Platecoils** — the prescription for solving pipe coil problems.

**PLATECOIL DIVISION, KOLD-HOLD MANUFACTURING CO., LANSING 4, MICHIGAN**

***As Management Sees It . . .***

**Firemen of the Los Angeles Fire Department are shown here training at Union Oil Company of California fire school on typical fires that may happen in refineries. The fire fighters are approaching a tower fire behind a fog blanket preparatory to shutting off flow of fuel that is burning.**

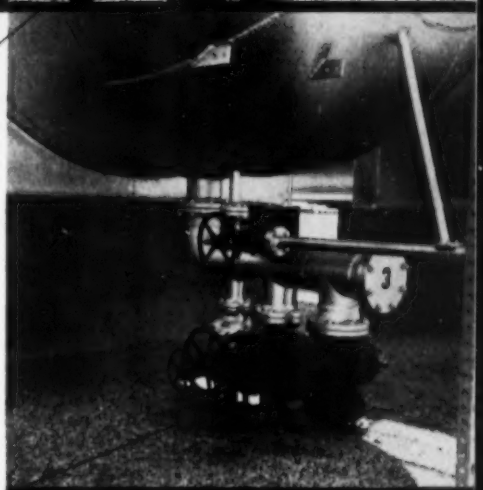
premise that there is no stronger motivation than enlightened self-interest. And in the case of the petroleum industry, it can be additionally justified by the fact that nearly always the incipient fire is within the control of some individual. So unless the individual is trained and motivated, first, to prevent it, and second, to control it, the chances of such a fire getting away are tremendous. In other words, fires are prevented by individuals and most cheaply and effectively controlled by individuals. Hence the basic approach to fire prevention should be addressed to the individual.

But it is axiomatic that if the planning of management fails to reach those who handle the tools or the extinguishing systems, the program fails. So the petroleum industry does not hesitate to invest time and money in fire prevention training—training which provides the employe with a thorough indoctrination on the chemistry of fire, fire control and extinguishment.

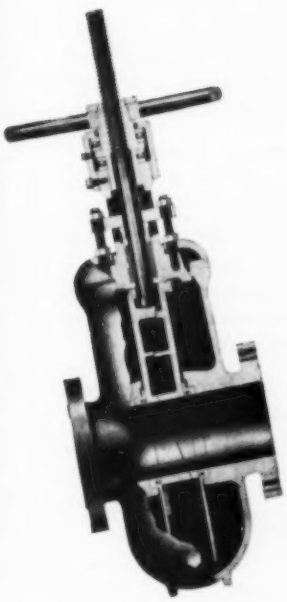
This training is done on live fires and the employe is taught to recognize the fact that often the most effective way to extinguish a fire is to remove the fuel supply. Some companies have spent considerable sums to erect fire training grounds on which fires can be ignited that will simulate actual operating conditions in the plant, such as electric motor fires, pipe trench fires and the three-dimensional fire that may occur when an overhead line ruptures. Training of this type helps the industry to maintain and improve its record in fire protection.

# W-K-M PROCESS VALVES FOR GASOLINE PLANT SERVICE

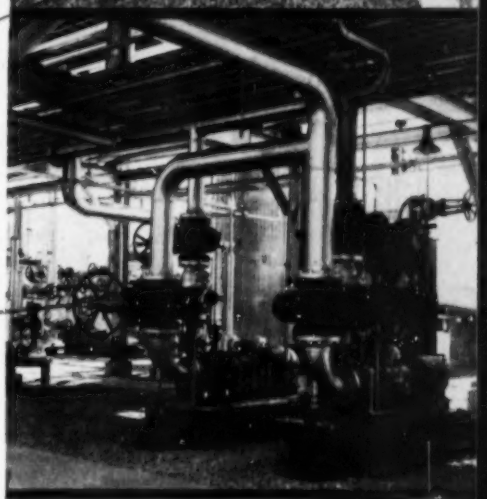
**When you figure that W-K-M Process Valves have metal-to-metal seals to provide complete safety under any conditions, that they permit full pipe-diameter flow without turbulence, that positive opening and closing are guaranteed by W-K-M's exclusive Leverlock design, that they can be completely overhauled with very little trouble while on the line, that they are available in any trim for any process service—high pressure hot or low pressure cold—it is no wonder that more and more gasoline plants and refineries are specifying W-K-M for the key jobs—and some plants use them all the way through. Write for Bulletin 698 for the complete data about these valves or ask for a W-K-M sales engineer to call.**



These valves and those shown below are in a gasoline plant in West Texas. Reading from left to right in above photo, the valves are in service on loading pumps handling butane, at 125 psi ga., 85° F; gasoline, 75 psi ga., 85° F; propane, 225 psi ga., 85° F.

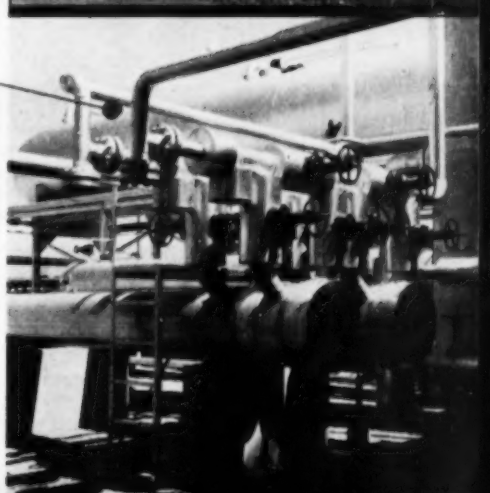


At left is cutaway section of the W-K-M Process Valve. Shown below is drawing of the exclusive W-K-M Leverlock mechanism which guarantees positive opening and closing under all conditions.



W-K-M Valves on butane stock tank at 125 psi, 80° F. Four valves are used on each tank and there are ten tanks.

These valves provide reflux to propane fractionator. They handle propane at 275 psi ga., 108° F.



These jacketed valves handle unstabilized gasoline at 550 psi ga., 260° F. in deethanizer feed exchanger.

W-K-M Valves

**W-K-M COMPANY**

P. O. BOX 2117 HOUSTON 1, TEXAS

2330 E. 8th St., Los Angeles, Calif.

Export Office: 30 Rockefeller Plaza, New York, N. Y.

# UNITED REFINING COMPANY marks its

# 50th Anniversary

## ...with a Blaw-Knox "Catforming" Plant

In line with its 50-year policy of using the latest refining techniques in the manufacture of premium quality products, United has commissioned Blaw-Knox Company, Chemical Plants Division, to design and construct a "Catformer" plant at their Warren, Pennsylvania refinery.

The Atlantic Refining Company "Catforming" process is an economical means for up-grading low grade naphthas to high octane gasoline at 95-100 per cent yield. The catalyst is selective and rugged; the yield-octane relationships are well established by pilot plant evaluation of numerous stocks; and commercial operations have confirmed basic design features.

Chemical Plants Division is licensed to offer Atlantic's "Catforming" process and would be pleased to discuss product yields and qualities, plant investment and operating costs with you. "Catforming" offers an economically attractive solution to your octane problem.

**BLAW-KNOX COMPANY**
**CHEMICAL PLANTS DIVISION**
Pittsburgh 22, Pennsylvania

# BLAW-KNOX

*As Management Sees It . . .*

# Let Supervisors Participate

- **You will reduce accidents**
- **You will improve efficiency**
- **You will advance public relations**

**F. E. Mathews,** Superintendent, Industrial Relations Division, Standard Oil Company (Indiana) Casper, Wyo.

PARTICIPATION IS the key to a supervisor cooperation program which has reduced accidents, improved plant efficiency, strengthened management-employe relations, and furthered public relations for the Casper refinery of Standard Oil Company (Indiana).

In effect, "participation" has augmented the refinery's one-man safety department with a safety supervisory force of 70—all of whom are plant supervisors.

The need for a new approach to the safety program became apparent a few years ago when lost-time accidents began happening on the average of one a month, and this despite the tireless efforts of a capable safety director. It was decided to enlist the active participation of supervisors, along with many rank and file employes. Foremen's meetings were placed under the direction of supervisors, with the safety director remaining in the background in an advisory capacity. The supervisor-chairmen began appointing committees to formulate programs for presenting materials which could be used by supervisors in employe group meetings. Those who did not supervise workers were put on inspection committees, policy committees, or given other special assignments.

### Rank-and-File Sharing

Duties were shared by the rank and file. Many craftsmen began conducting demonstrations, appearing in role-playing programs, or participating in other efforts to improve the safety program.

The result, while not immediate, was a gradual lessening of lost-time accidents. There was one 423-day stretch—1,600,000 man-hours—when there was not a single lost-time accident.

Participation also stimulated interest in the supervisory training program. The technique of lecture-type meetings was discarded in favor of panel discussions, more visual aids, short skits—all designed to increase participation. The discussions were led by supervisors with special training along various lines. For example, the plant manager spoke on the history of the company. The chief engineer was in charge of a conference on pump construction. This session did not make the supervisors experts on pump problems, but every man gained an overall knowledge of the subject which aided him on his job.

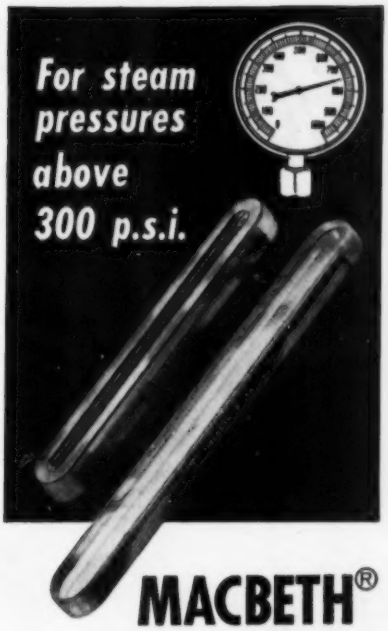
### "Value of Tools"

The assistant superintendent of the mechanical division presided at a conference on the "Value of Tools and Equipment." Figures were presented to stress the cost of many tools with the view toward increased economy.

The office manager conducted a meeting on "Cost and Analysis." He took the various records submitted by the supervisors, together with other information, and explained what is done with the data received and how it is finally assembled and used to arrive at refinery costs. This session was followed by a panel discussion on "Cost Control," led by the plant superintendent and two division superintendents.

### Union Working Agreement Panel

A supervisor in the light oils division conducted a conference on process fundamentals, designed to give all the supervisors a general knowledge of what a refinery is supposed to do. Heat exchangers, tar coolers, power equipment, boilers, etc., were discussed. Refinery flow charts were used to show the progress of various products processed. A panel discussion was held on




MACBETH®
flat gauge glasses
give you safe, easy reading

Designed for steam pressures exceeding 300 p.s.i., MACBETH flat gauge glasses resist the corrosive effects of steam, to provide clear visibility for a long period of time.

Rugged, thermally resistant construction provides maximum safety for steam pressures as high as 2500 p.s.i. and for special low temperature applications to 15,000 p.s.i. You save on replacement costs, gauge maintenance is held to a minimum.

Two types of MACBETH flat gauge glasses are available: Type A (plain) used in pairs with water column between; and Type B (reflex) used singly with water in contact with full length prisms.

Your Industrial Distributor stocks MACBETH brand gauge glasses and the complete Corning line. Call him today, for the best in economy and protection.

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

| Application | Recommended Product |
|---|---|
| Normal Conditions (Up to 100 p.s.i.) | CORNING brand standard gauge glasses |
| Higher temperatures | PYREX brand high-pressure gauge glasses |
| Higher pressures | PYREX brand heavy-wall gauge glasses |
| Extra visibility | PYREX brand red-line gauge glasses |
| Viewing inside furnaces, reactors, pressure vessels, etc. | PYREX brand sight glasses |
| Lubrication inspection | PYREX brand lubricator glasses |
| Visible discharge devices | PYREX brand oil cup glasses |

TRADE MACBETH MARK

CORNING GLASS WORKS
Corning, New York

*Corning means research in Glass*

# Here's a handy guide to the selection of metering and proportioning pumps

In this new catalog and pump selection manual for Hills-McCanna "U" Type Metering and Proportioning Pumps is all the information, including prices, for the selection of exactly the right pump for handling over 300 substances. Clearly and concisely, this helpful booklet gives all the necessary information and specific recommendations to cover the vast majority of needs that can be filled with a Hills-McCanna "U" Type Pump.

If your operations involve the metering or proportioning of small volume flows, you will find this catalog a useful addition to your files. We will be pleased to send you a copy on request. HILLS-McCANNA COMPANY, 2441 W. Nelson St., Chicago 18, Illinois.

*Hills-McCanna "U" Type Pumps are reciprocating, variable stroke, mechanical drive units with maximum capacities ranging from 0.10 to 24 gph. per feed. One, two, three and four feed assemblies are available. Operating pressures up to 5,000 psi. A four feed unit is shown at the left.*

**HILLS-McCANNA**

***metering and proportioning pumps***

***Also Manufacturers of: Saunders Patent Diaphragm Valves Force Feed Lubricators • Magnesium Alloy Sand Castings***


## *As Management Sees It . . .*

the working agreement with the union. Another on "Coordinated Planning" was handled by an assistant general superintendent and emphasized the coordination needed to do the work economically.

Discussions have been held on many other subjects, yet so far the surface has barely been scratched. No doubt consideration will be given to craft training programs for pipefitters, riggers, electricians, boilermakers, welders, process operators, and others. It is possible that blue print reading will be included. Rapid reading is another possiblity. There are many who feel that much of the material going over the average supervisor's desk is wasted because he simply does not have time to read it all.

At the beginning, there was some complaint among the supervisors about the time required to prepare for these meetings. But this feeling gave way to pride as they were made to realize the value of their contributions to the program.

Some of the reluctance to participate stemmed from a shyness of appearing before others. This was relieved by the coaching activities of the Training Department. A tape recorder was put at the supervisors' disposal so they could polish their programs in advance. A library was made available to help solve problems on training, supervision, industrial psychology, bargaining techniques, and other related subjects.

As a further aid to the supervisors, the company conducted a course in oral expression. The result, as one supervisor put it, is that "the company is making salesmen of the refinery supervisors. They are training us in public speaking. They are teaching us many things about our company that have nothing to do with our specialties. I am studying many things, from psychology to economics. The company is teaching me how to be a good salesman for our company and our American free enterprise system."


ACKNOWLEDGMENT

This article is a condensation of a paper, "Participation—Key to Supervisor Cooperation," presented at the February 12-13, 1953, meeting of Western Petroleum Refiners Association at Beaumont.


## Duncan Retires from General

O. Norman Duncan, assistant refinery superintendent for General Petroleum Corporation's Torrance, Calif., refinery, has retired after nearly 34 years in refinery operations. Duncan was first employed in June 1919 as a fireman at General's Vernon refinery. He has been headquartered at the Torrance refinery since 1941.

# R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

*R-S Valves provide quick opening yet tight means of overflow control. Photograph courtesy William Allen Son's Company, Worcester, Mass.*

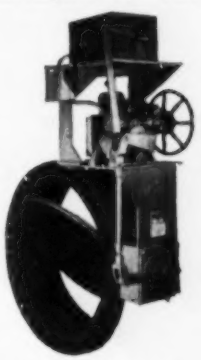
## Specify R-S VALVES

- for simplified and economical control and shut-off of volume and pressure
- with metal to metal seat including babbit or rubber seat
- for manual or any type of automatic control
- for any material that flows or is forced through a pipe
- in any material that can be cast or welded including plastics and certain alloys especially adapted to resist corrosion, erosion and temperature.
- in all sizes for all industries and processes, and in the temperature range from minus 300° to plus 2000° F. 2 to 2500 psig.

Representatives are listed in telephone directories as: "R-S Products Corporation Valves".

**No. 674—Special 2½-inch stainless steel valve with 150 psi construction. Standard sanitary type threads. Heavy duty handlever assembly Type No. 681.**

**No. 848—Heavy duty valve with rubber seat for water service at high velocity. Handwheel operates valve through spur gear and pinion into a threaded reach rod (enclosed Type No. 700) in order to obtain sufficient torque to seat disc in rubber.**



**No. 847—Heavy duty valve with electric motor operator mounted directly above valve and positioned by pressure controller mounted above the motor.**

Consult your local R-S Valve Engineers, or write direct.

**R-S PRODUCTS CORPORATION • 4600 Germantown Ave., Philadelphia 44, Pa.**

*An S. Morgan Smith Company Subsidiary*

**DISTRICT OFFICES IN PRINCIPAL CITIES**

# The first line of reducers is still the foremost line

T F

Old timers will recall the day—more than 20 years ago—when Taylor Forge announced the first comprehensive line of butt-welding fittings.

Before the WeldELL line was introduced, the only available welding fittings were elbows. But in the WeldELL line came all the fittings needed to do a complete and workmanlike job of pipe welding . . . the tees, reducers, caps, stub ends, and welding flanges.

To produce all of these types of fittings in seamless forged steel was a giant undertaking—and still is. A good example of this is the line of reducers. Today there are 175 reductions in standard weight reducers alone—and this can be multiplied by all the weights and materials in which Taylor Forge reducers are available.

The first line is still the foremost line—the engineered line, the full value line. For up-to-the-minute facts about the WeldELL line, see your Taylor Forge Distributor.

# TAYLOR FORGE

**TAYLOR FORGE & PIPE WORKS**

General Offices & Works • Chicago 90 • P. O. Box 485

Plants at Carnegie, Pa., Fontana, Calif., Gary, Ind., Hamilton, Ont., Canada

**Editor's Note:** *It is axiomatic in the petroleum industry that accidents seldom happen to experienced workers on hazardous jobs. It is the easy routine task that invites carelessness and causes injuries. This is the first of a series of pictorial safety messages taken directly from the accident experiences of refineries and natural gasoline plants. Only the names of the persons and companies involved will be omitted. Clip them. Put them on your bulletin board. Drive home the warning that IT'S EASY TO GET HURT.*

**The Accident:** Operator was washing down a concrete area at a distilling unit. The hose split under the pressure of steam and the operator was seriously burned by a spray of hot water.

**Recommendation:** Because this hose was only two or three months old and apparently effective, it is assumed that it had been left lying across open steam lines or had been mashed by heavy equipment during shutdowns. An all-out effort will be made to keep each hose on the rack provided for them when not in use; and periodic inspections will be made by all operating departments using steam hoses of any kind.

# Improved Safety Record a Factor In Possible Insurance Rate Cut

ANNOUNCEMENT of an improved safety record for 1952 and the simultaneous advancement of legislation aimed at removing expensive abuses in granting workmen's compensation benefits brightened the hopes of the Texas oil industry last month for relief from towering insurance rates.

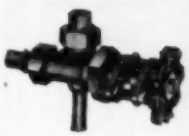
House Bill 261, said to have the backing of 100,000 Texas employers, was awaiting its turn for consideration by the House after clearing the State Affairs Committee. Major concern of its proponents was not the opposition which might be encountered on the floor, but whether its turn in the House would be reached before adjournment, originally set for May 12. Lengthening of the legislative session until July 1, as some expect, would greatly enhance the bill's chances of approval in both House and Senate.

Proponents of the measure expect

■ See INSURANCE page 265

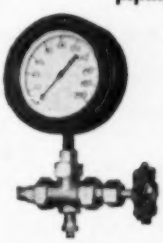
Sound Design
Quality Materials
Precision Workmanship
the superiority of
JERGUSON VALVES
speaks for itself

**OS&Y Valves for severe conditions**



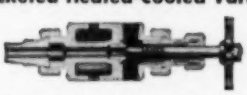
Rugged Jerguson OS&Y Valves are the ideal answer to meet high temperature or corrosive conditions where inside threads can't be tolerated. Efficient outside thread design eliminates possible freezing and allows the valve stem to work freely at all times.

**GA Valves for instrument piping and general use**



Tremendous time and cost savings are possible with Jerguson GA Valves. Threaded connections can be reduced from 10 to 3 . . . unions, nipples, reducers, elbows, tees, valve, and bleed valve are combined in one space saving unit.

**Jacketed Heated-Cooled Valves**



Designed especially for use with heated or cooled gages, Jerguson No. 93 Valves have a surrounding jacket for circulating the heating or cooling medium. They give safe, dependable, leak-tight service.

**Globe Valves**

Jerguson Globe Valves, furnished in ¼, ½, and ¾ inch sizes with renewable, regrindable seats. Can be furnished with Stellited stem and/or OS&Y.

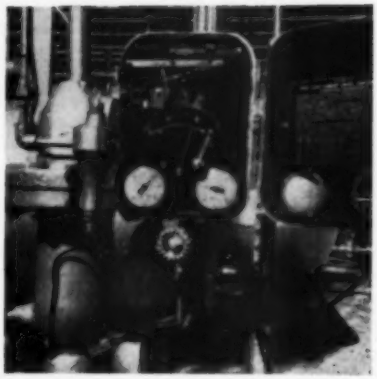
*All valves shown rated at 3000 lbs. @ 500°F. Send for detailed Data Units . . . or outline your requirements and let Jerguson engineers go to work for you.*

JERGUSON
*Gages and Valves for the Observation of Liquids and Levels*
**JERGUSON GAGE & VALVE COMPANY**
**100 Fellsway, Somerville 45, Mass.**
*Offices in Major Cities*
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

# [ How to Do It ]

## . . . Can turn your ideas into dollars:

- Here's a chance to cash in on your ideas. Every plant has its own improvisions and gadgets, so this contest is made to order. It's as easy as one, two, three; all you need to do is:
  1. Jot down your How to Do It idea.
  2. Roughly sketch it, showing how it works, or take a clear photograph.
  3. Send it to us with your name and address. As long as the writing is readable and the drawing understandable, send it in. We'll handle it from there. Every entry accepted—whether printed or not—wins $10!
- At the end of 1953 all entries printed will be judged for:
  ORIGINALITY—how new the idea is.
  VALUE TO THE COMPANY—how much it can save in time, money and labor.
  APPLICABILITY ELSEWHERE—how useful it will be in other plants.
- The idea adjudged best wins $100; second place gets $50 and third prize is $25. Enter as many times as you wish. To get an idea of what we want, check the items on this page. Then submit your own How to Do It ideas to Editor, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

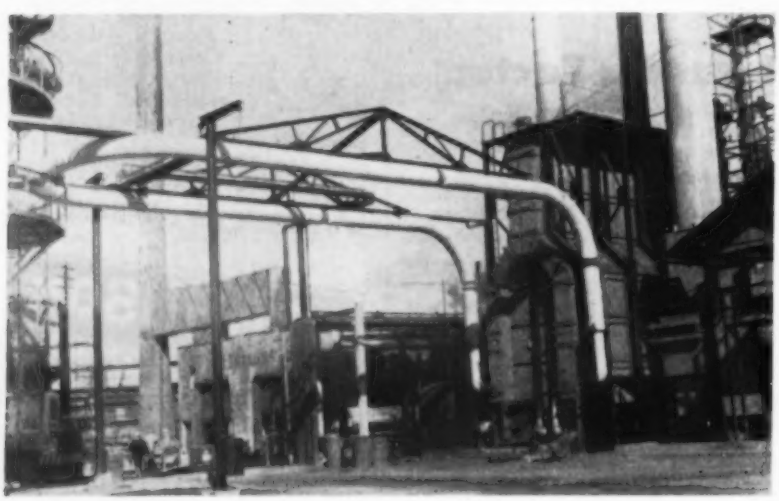


## Novel Defroster Prevents Pressure Control Failure

Freezing weather is tough on operators—but is is even tougher on pressure controllers. Even in the best instrumented plants, some moisture frequently gets in instrument air lines and, coupled with freezing temperatures, puts completely out of action a pressure controlled motor valve. The device shown in the illustration is a seemingly crude but undeniably effective way of preventing this major equipment failure.

Two holes are drilled in the back of the pressure controller case, one on each side of the diaphragm housing. Copper tubing is inserted through one side, looped around the diaphragm housing, and withdrawn from the opposite side. One end of the tubing is connected to an exhaust steam line. This hookup gives perfect assurance of freeze-free operation and is inexpensive. Over 50 instruments have been successfully adapted at the author's plant.

This item, a prize winning "Operation Kink" at the NGAA Meeting held in Tyler, Texas, October 24, 1952, is by Ovid Phillips, Warren Petroleum Corporation.



## Truss-Type Bridge Solves Roadway Crossing Problems

A tough (but common) design problem was licked by the application of a little ingenuity. In constructing additions to process units, the problem frequently arises of crossing existing roadways with new piping. Of course the conventional method of supporting the pipe with stanchions can't be used. Here is one excellent solution to the problem.

A truss-type bridge was built to support the transfer line at both ends. On either side of the roadway two standards were erected with counterweights to support the piping, bridge and accessories, and provide the necessary balance to counteract expansion and contraction.

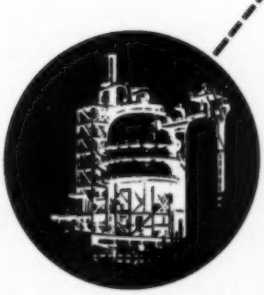
This novel type structure permits ample clearance for vehicles entering the area.

See more "How" items page 224.

# Nalcat® DELIVERS

## Cracking Catalyst Performance

## on the Dot



Nalcat

FLUID CRACKING CATALYSTS

CATALYST DIVISION
NATIONAL ALUMINATE CORPORATION
4001 West 71st Street,
Chicago 29, Illinois

**All business is specialized**

*. . . and nothing specializes on your business like your business paper*

This bright bird *specializes*. He picks out the cold customer who's a hot prospect. And it *pays!* Specializing pays in your business too . . . most of all when you're looking for data on new products, new ways of doing business. That's why this business paper of yours is so vital. It specializes on your business—scouts for facts you need to solve your specific problems. Editorial pages and ads *both* bring you a heap of help. Like all the best informed people in your field, you'll find you always keep a step ahead when you read . . . clip . . . use every issue, to do more business better.

This business paper in your hand has a plus for you, because it's a member of the Associated Business Publications. It's a *paid* circulation paper that must *earn* its readership by its quality . . . And it's one of a leadership group of business papers that work together to add new values, new usefulness, new ways to make the time you give to your business paper still more profitable time.

Above message is
One of a series of ads prepared by
THE ASSOCIATED BUSINESS PUBLICATIONS

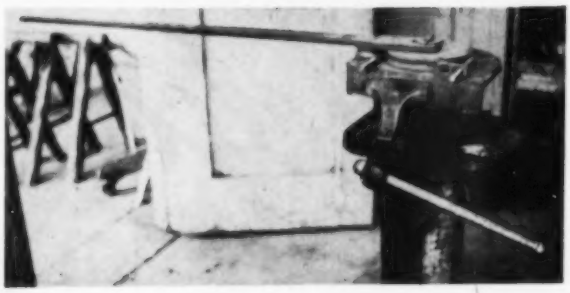
PETROLEUM REFINER is specialized for the Refining-Natural Gasoline-Petrochemical Industry.

FIRST in editorial quality.
FIRST in oil refining circulation.
FIRST in advertising results.

**PETROLEUM REFINER**
*A Specialized Petroleum Publication of*
**GULF PUBLISHING COMPANY**
*World's Largest Oil Industry Publishers*

*How to Do It . . .*

# Clamp Bolts Made With One Sweep

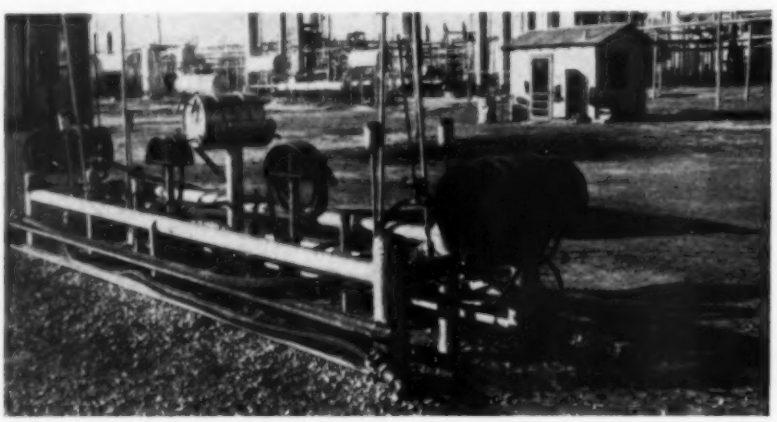


Pipe saddle or clamp bolts can be formed with the aid of the simple tool shown in the illustration. The tool is easily constructed from scrap metal.

The base is a section of heavy plate. One edge is turned at a 90-degree angle to facilitate clamping in a standard machinist vise. Two circular-grooved sheaves are provided, one for six-inch and the other for four-inch bolts.

On one side of the base and above the lip he'd in the vise are holes drilled through a bar welded to the base. The handle or lever rotates on a pin securing the four- or six-inch sheave, and contains a small grooved sheave properly spaced with respect to the holes in the handle.

The bolts are cut to length and threaded. One end of the straight bar is passed through the hole, and a nut is attached to prevent pulling through the anchor hole. One sweep of the long handle makes a perfect U-bolt.



# Rounded Corners Cut Hose Repair

The hose rack shown in the photograph was devised to reduce the wear and tear on gasoline loading hose resulting from contacts with sharp corners.

Two split pipes serve as storage troughs for the loading hose proper. The smaller hose is wound carefully on cylinders made from discarded 55 gallon drums. Intermediate saddle supports are made from the same material.

The result—a tidy orderly method of storing hose with no part of it contacting a sharp corner.

# Welding Square Simplifies Alignment of Pipe Flanges

Take the guess work out of welding flanges to pipes by using the simple little aligning device shown in the illustration. The offset square is made of ¼-inch tempered steel, with the longest side designed to lay squarely against the outside wall of the pipe. The inverted U-shaped turn was devised to cross over the flange and allow the square to rest snugly against the pipe surface.

Two men, the welder and his helper, handle the tool. The helper holds the

PETROLEUM CHEMICALS DIVISION

# NEWS

May ★ One of a Series of Interest to the Petroleum Industry ★ 1953

## What

**are the advantages of buying gasoline additives from Du Pont?**

1. **COMPLETE LINE**—Du Pont is the *only* supplier manufacturing a complete line of gasoline additives.
2. **EXPERIENCE** — Du Pont has had longer experience than any other U. S. company in making TEL (30 years). It has been making dyes for over 30 years; antioxidants 20 years and Metal Deactivator for 14 years.
3. **QUALITY** — Through the years Du Pont has set up quality control methods that are probably unsurpassed.
4. **TECHNICAL SERVICE** — To help refiners get the best results in the use of additives, Du Pont maintains *five* strategically located district laboratories.
5. **ECONOMY** — In many cases, the Du Pont district laboratories have been able to help refiners substantially reduce their cost of using additives.
6. **CONVENIENCE** — To assure fast, dependable deliveries, Du Pont maintains conveniently located warehouses, rail sidings and truck facilities throughout the country.

## Petroleum Laboratory Has New Information On Deposit Formation

Until recently, there has been very little information on the reaction mechanisms which result in the accumulation of combustion chamber deposits—especially deposits formed by fuels containing tetraethyl lead.

Since nearly all modern automotive fuels contain tetraethyl lead, the Du Pont Petroleum Laboratory undertook a study of the sequence of chemical reactions which occur in engine deposit formation. The study is part of a continuing series of investigations on the mechanisms causing combustion chamber deposits.

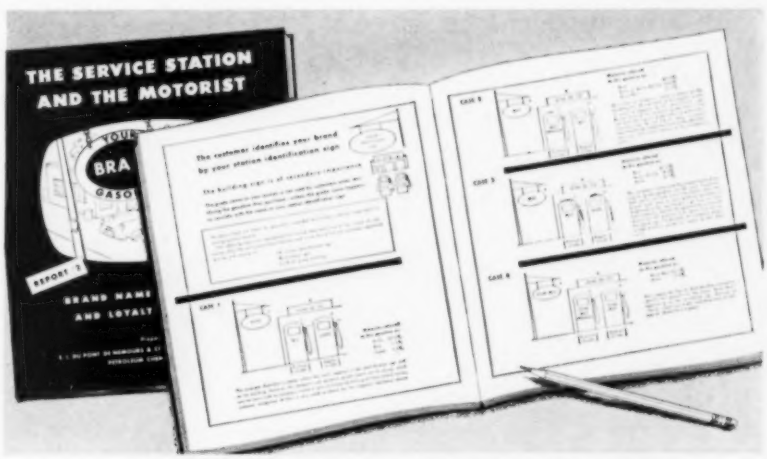
Briefly, the study revealed the following:

1. The course of deposit forming chemical reactions is dependent on the temperature of the combustion chamber walls.
2. Gaseous lead oxide, produced from the decomposition of tetraethyl lead, does not undergo vapor state reactions—except when the gas layer near a clean combustion chamber surface is cool.
3. Solid lead oxide which condenses has a short life as a deposit constituent. It is attacked by acid gases to form simple lead salts or reacts with the simple lead salts in solid state reactions to form complex lead oxysalts.

## How Loyal are Service Station Customers to Your Brand Name?

***Report No. 2 in Du Pont's survey of consumer buying habits reveals interesting statistics on brand name recognition and loyalty to brand***

As an oil company executive, facts about your customers and potential customers are vitally important to you. They are the basis for sound advertising, sales promotion and marketing plans. The Du Pont survey of consumer gasoline buying habits is designed to help give you the facts necessary to perfect such plans.




**THE DATA** presented in these two pages of Report No. 2 show that a big majority of customers recognize the gasoline sold at a station by the name on the big identification sign erected in front of the station.

The survey itself is based on many thousands of customer interviews and service station observations. As such, it is too voluminous for easy distribution. It is, therefore, being broken down into a series of easy-to-digest reports in booklet form. The first of these reports—issued in March of this year—covered service station selection and loyalty.

### WHAT'S IN A NAME?

Report No. 2—"Brand Name Recognition and Loyalty to Brand"—is now ready for distribution to oil company marketing groups. It contains a comprehensive discussion of motorists' loyalty to certain brands and *reasons* for their loyalty.

The tremendous sales power of your brand name is borne out by the survey. For example, the number of motorists loyal to a preferred brand is *greater* than the number loyal to a "usual" service station. And the degree of loyalty in length of time and in quantities of gasoline purchased is also greater. What's more, two out of three people

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Survey Report*

say they buy a preferred brand *exclusively.*

These purchase habits are all documented and graphically illustrated in easy-to-follow form in Report No. 2 on the survey.

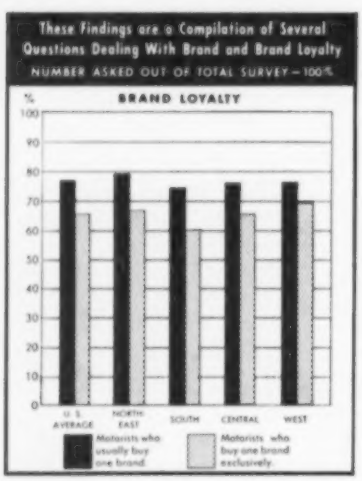
### FACT OR BELIEF?

During the customer interviews, however, it was determined that many motorists base their choice of a gasoline brand—or prejudice against it—on *belief* rather than *fact.*

No product is purchased without the buyer's belief that it will satisfy his needs. Because of this, motorists are inclined to answer questions about gasoline brands in terms of brands that are *acceptable* to them.

On the other hand, people "believe," "think" or "have heard" that certain gasoline brands are of poor quality. In the survey 181 brand names and 3 brand groups received some mention as "a brand I would not buy."

A thorough study of replies showed that the reasons for acceptance are based almost entirely on quality *belief.* And the reasons for quality belief are nearly always connected with car performance. But service, friendship and station location were also mentioned frequently in addition to product quality as reasons for the motorists' purchase selection.




**A TYPICAL CHART** from survey Report No. 2. It shows that 77% of the motorists in the United States have a favorite brand and usually buy it . . . 66% buy one brand exclusively.

### BRAND NAME VS. GRADE NAME

An analysis of consumer buying habits also shows that there is little recognition by the motorist of gasoline "grade" names carried on service station pumps. In fact, motorists nearly always name gasolines according to the names carried on the big station brand identification signs. And the grade name is not a sales factor until after the decision to buy a certain brand is made.

The above are highlights of Report No. 2. More detailed information on grade choice will appear in Report No. 3, which is scheduled for publication sometime this summer.

Findings contained in these reports are based on 3,100 household interviews supplemented by 21,000 observations at 1,193 service stations.

National in scope, the survey is representative of gasoline buying patterns and trends throughout the country. We believe it is the most comprehensive market survey ever undertaken by any segment of the petroleum industry.

## Central District Manager

EARL G. BENNETT, manager of the Du Pont Petroleum Chemicals Division central district, joined the Du Pont Company in 1931.

He was first assigned to the Grasselli Chemicals Department's Grasselli, New Jersey plant. He was later transferred to the Alcohol Division of the Organic Chemicals Department in Wilmington. There he did both technical work at the Jackson Laboratory and sales development work in connection with Du Pont's gasoline and lubricating oil additives.

In 1936, Mr. Bennett was assigned to special work with the Standard Oil Company of Indiana and The Pure Oil Company in Chicago on gasoline stability studies.

In 1939, he was transferred to Chicago in charge of sales in the western area for the Alcohol Division, which then included Du Pont's petroleum chemicals and dyestuff intermediates. He returned to Wilmington in 1943. In 1947, he was appointed Central District Manager, Petroleum Chemicals Division, in Chicago.

**EARL G. BENNETT**

He was graduated from Clarkson College of Technology in 1931 with a B.S. in chemical engineering. He is a member of the American Chemical Society, the Society of Automotive Engineers and the American Petroleum Institute.

## *LITERATURE AVAILABLE*

Here is a partial listing of the bulletins, reports, booklets and aids available to you through any Du Pont Petroleum Chemicals Division district office:

**The Service Station and the Motorist** — Report No. 1. An authoritative study of the four major gasoline marketing areas showing why motorists select certain service stations . . . and remain loyal to them . . . Serial A-5396

**Du Pont Fuel Oil Additive No. 2** — A 12-page bulletin describing this ashless stabilizer and dispersant that prevents clogging of fuel oil screens . . . Serial A-5201

DU PONT
Better Things for Better Living . . . through Chemistry

# Petroleum Chemicals

**E. I. DU PONT DE NEMOURS & COMPANY (INC.)**
*Petroleum Chemicals Division* • *Wilmington 98, Delaware*

*District Offices:* New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

*District Laboratories:* Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

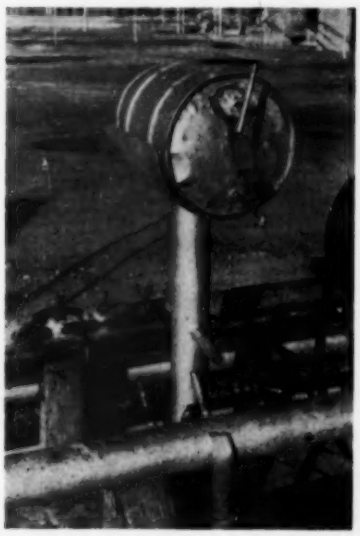
IN CANADA: Canadian Industries Limited — Toronto, Ontario — Montreal, Quebec — Calgary, Alberta

*ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)*

A-5379

Printed in U. S. A.

fittings and square in position while the welder makes the necessary tacks to hold the flange in position. With the flange rigidly attached, it is a simple job to complete the weld with a bead on the point of contact.

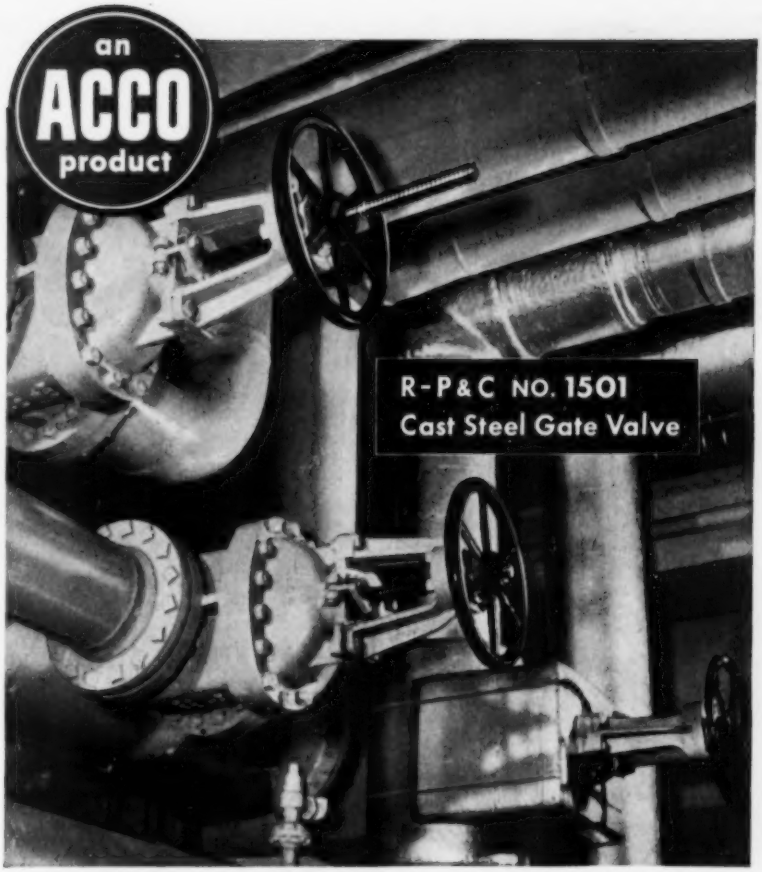


## Discarded Drum Makes Good Container for LPG Odorant

That old standby, the discarded 55-gallon drum, is used to provide a container for LPG odorant. The holder for the drum is a substantial post topped with a properly curved saddle. The drum is fitted with a ¼-inch withdrawal line and gate valve to insure easy control of the required volume of odorant. The filler bung hole has a "T" handle welded to the closure so that it may be opened and closed readily.

## Speed Exchanger Cleaning With Manual Chain Hoists

Hand operated chain hoists will speed exchanger cleaning. The hoists shown in the picture were a part of the original installation of the structure. The hoists are anchored from horizontal beams supported above each bank of exchangers. These beams parallel the exchangers and are designed with flanges to serve as a track for the hoist trolleys. Thus the tube bundles can be pulled and moved the length of the structure. Adequate space is built into the top floor so that tube bundles




**How R-P&C Valves Reduce Maintenance Costs**

• Six important features of R-P&C Cast Steel Valves eliminate many service troubles which in turn reduces maintenance costs.

First of all . . . they're made from electric furnace steel which means sound castings. All parts are designed for equal strength and great toughness. The bodies resist distortion. Permanent alignment is provided by the rigid one-piece yoke. And the gland packing stays tight even at high pressures and temperatures. Furthermore, the design detail assures smooth flow and positive shut-off.

You can get R-P&C Cast Steel Valves in gate, globe, angle, stop and check, and swing check types. Variety of trim metals for air, gas, liquid, oil, steam, water. Wide range of pressures and temperatures. Screwed, flanged, or welding ends. Sizes range from 1½" to 24".

Specify . . . and *get* . . . R-P&C Cast Steel Valves next time you order.

ACCO

R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE

Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

R-P&C valves

All Metal THERMOMETERS

with WESTON dependability built-in

The heart of the modern, dial-type thermometer is the all-metal temperature element. Developed over 15 years ago, the WESTON all-metal element has plenty of proof behind it. In fact, the dependable accuracy of this unit has made the readable WESTON thermometer favorite for laboratory use as well as for all industrial temperature needs. For *extra* dependability, specify WESTON all-metal thermometers . . . available in the types, ranges and sizes indicated below. Literature available. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

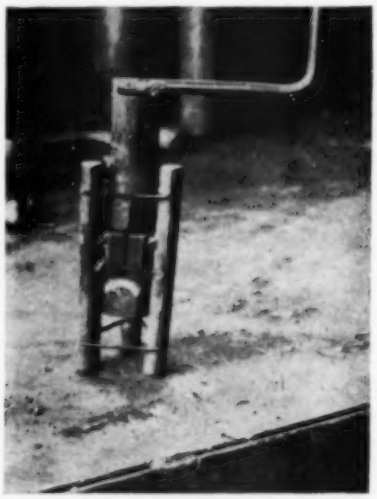
| Type | Scale Length | Ranges | | Stem Length | | % Accuracy of Thermo. Range |
|---|---|---|---|---|---|---|
| | | As low as | As high as | As short as | As long as | |
| Heavy Duty Straight Form | 9" | −100F | +1000F | 2½" | 48" | 1 |
| Heavy Duty Angle Form | 9 or 12" | −100F | +1000F | 2½" | 72" | 1 |
| Standard Angle Form | 6" | −100F | +1000F | 2½" | 72" | 1 |
| General Purpose | 4½" | −100F | +1000F | 2½" | 36" | 1 |
| Laboratory | 3.40" | −100F | +500F | 2" | 24" | ½ of 1 |

WESTON *Instruments*

799




can be pulled, cleaned and repaired without carrying them to the repair shop.

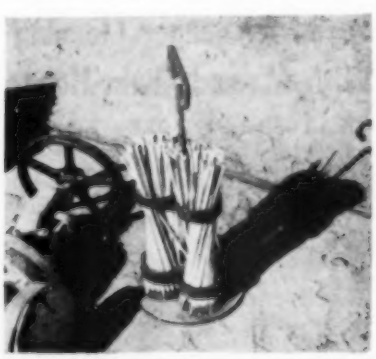


## Alignment for Welding Aided by Expanding Wedge

Straight alignment of two sections to be joined by welding is aided with the use of the gadget shown in the photograph. An alert mechanic developed the expander which works on the same principle as an expanding reamer.

Three round pieces of bar steel are welded to a split center piece having a hollow cone-shaped end bearing a cone nut. A bolt passing through the split piece enters the threaded nut. To preserve the required tension on the bars, the ends are held snugly in place with springs.

The tool is long enough to pass through a two-inch fitting into a pipe. When pressure is applied by expanding the rods, the fittings are in alignment and ready for welding.



## Welding Rods Carrying Kits Ends Search for Right Rod

Tired of forever scattering welding rods over the ground and having to take time out to look for the right type

## They call it

# "THE LEAK-PROOF FLEET"—

## It's equipped with Rockwood Ball Valves

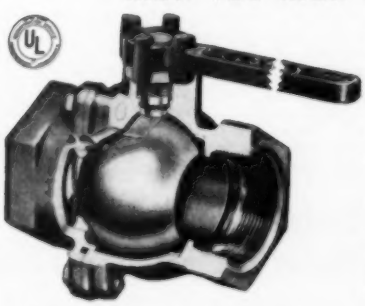
Carrying bottle gas in bulk over city streets is ticklish business.

But this large Transport Company made one decision and stopped a thousand worries. They equipped the fleet throughout with Rockwood Ball Valves. Not even the bumps of rough pavements or the jolts of quick stops and starts unseat these close-fitting valves.

Best part of it is, Rockwood Valves *stay* leak-proof. They resist wear, yet retain the quick-opening and closing features. They require no maintenance.

Rockwood Ball Valves handling "bottled gas" are operated every two minutes during the day. Tight seal makes them real production boosters and cost cutters.

### WHAT YOU WANT . . . ROCKWOOD HAS



*Tested by Underwriters' Laboratories, Inc.*

**Full Round Flow,** with no change in shape or volume of the fluid and no turbulence. Minimum friction loss.

**Quick Operation** in opening and closing means faster loading and unloading.

**Long Life,** because made to resist abrasion and wear.

**Low Maintenance** because engineered to stand up under an anticipated daily grind.

**ROCKWOOD *FULL-FLOW* BALL VALVES**

**THE FLOW IS AS ROUND AS THE PIPE ITSELF**

Get complete details on this great new advancement in valve engineering. Send for booklet.

**Distributors in all principal cities**

**ROCKWOOD SPRINKLER COMPANY**
**102 HARLOW ST., WORCESTER 5, MASS.**

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name .....
Title .....
Company .....
Street .....
City .....
Zone ..... State .....

It's a lot easier to work with

RIDGID

Extra-Utility Pipe Vises

Compare those work-saver RIDGID Vises with any others and you see the bonus of extra utility you get for your money. Kit vise is easily toted to the job, quickly clamped on edge of bench or plank, ready to use. All other RIDGID vises have handy integral pipe benders and rests to make cutting and threading easier. Full-width firm-gripping jaws of top quality tool-steel, bodies of rugged special malleable—for years of service. 9 models, yoke and chain, 23 sizes, meet every need. Get your money's worth—buy RIDGID Vises at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

RIDGID

Work-Saver Pipe Tools

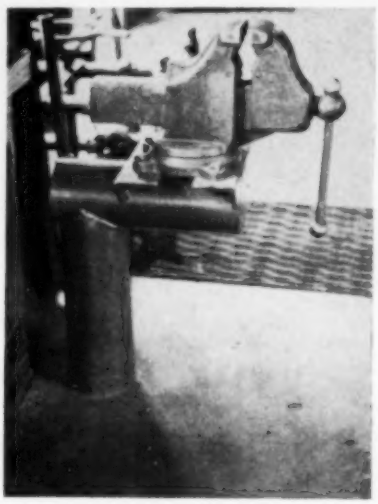



of rod, one welder got busy and did something about it. With very little effort and practically no expense he devised the handy little carrying case shown in the photograph.

Though simple, this little gadget provides the right rod at the right time with no fuss or bother.

The base of the case is formed by a circular plate. A vertical stem made of ⅛-inch rod is tacked to the center of the base. The stem serves as a lifting device.

At three equidistant points around this stem, rings are tack welded to hold the welding rods. Another set of rings near the top of the center stem provides additional support. The device saves time and eliminates a bothersome search.



## Discarded Material Makes Handy Stand for Pipe Vise

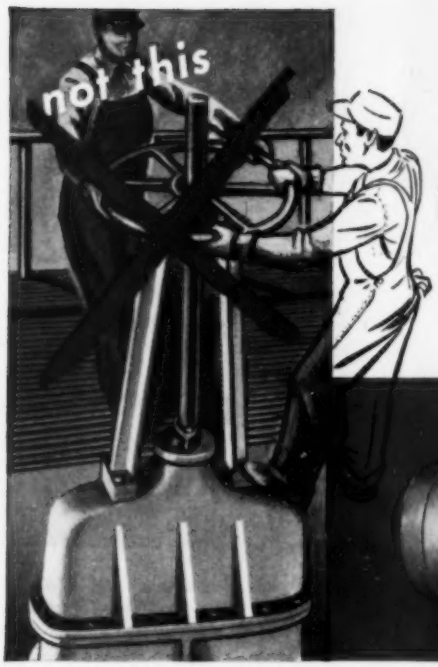
Locate pipe vises near the job site easily and permanently. The picture shows how this can be done with the help of some discarded six-inch nipples and a welding torch.

One nipple is set in the concrete floor near the equipment that requires frequent maintenance. This section is topped at right angles with a second nipple which provides a stand for the vise. Two sections of angle iron are welded to the horizontal nipple to provide an easily drilled base for the vise. The latter is of the swivel type, thus providing maximum flexibility.

## Contaminants Taken From Amine Solution With Filter

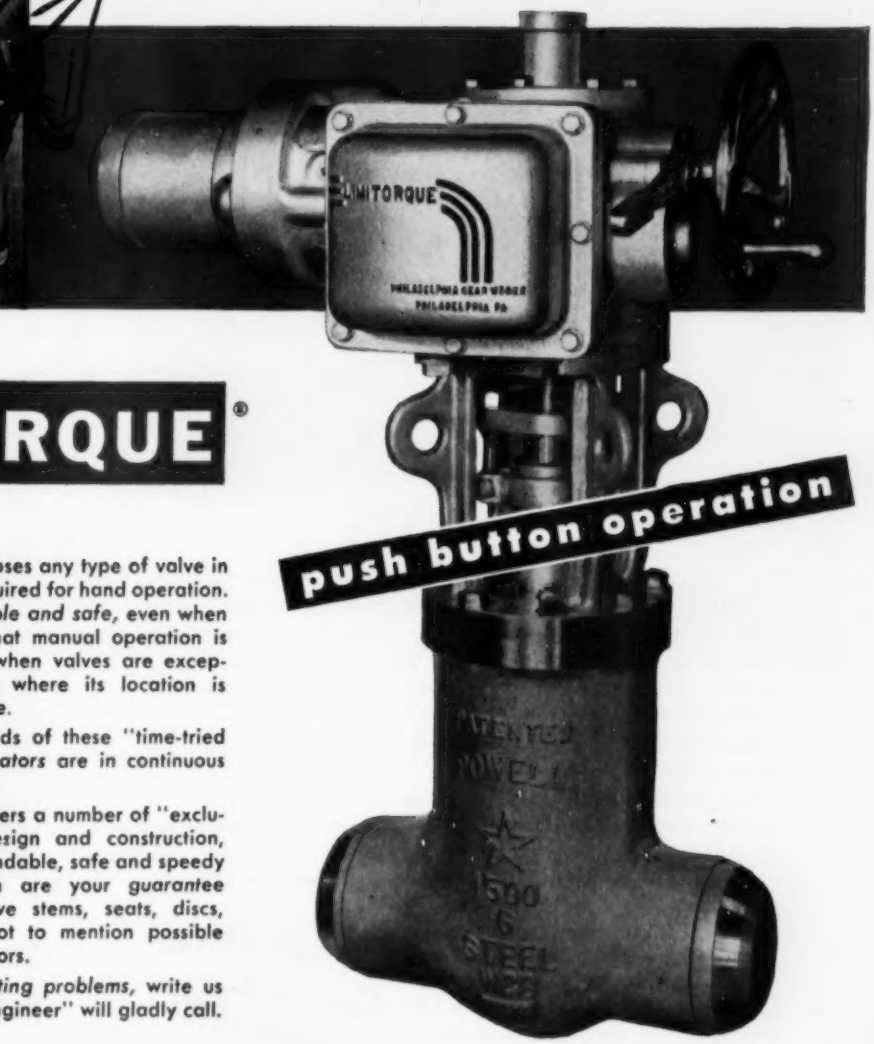
Continued recirculation of heavy particles and contaminants in one operator's amine solution caused frequent damage to pumps and control valves. His answer to the problem was the shop built filter shown in the illustration.

It is easily constructed of 12-inch pipe with a welded plate on one end and a flange on the other. The concrete foun-




# Pushing a Button

## is SAFER EASIER QUICKER




## LIMITORQUE®

## push button operation

*LimiTorque* opens and closes any type of valve in a fraction of the time required for hand operation. It is *absolutely dependable and safe,* even when pressures are so *high* that manual operation is almost impossible . . . when valves are exceptionally *hot* . . . and where its location is *hazardous or inaccessible.*

Thousands upon thousands of these "time-tried and tested" *Valve Operators* are in continuous use, all over the world.

Of course, *LimiTorque* offers a number of "exclusive advantages" in design and construction, which not only give dependable, safe and speedy performance, but which are your *guarantee* against damage to valve stems, seats, discs, plugs, or gates . . . not to mention possible physical injury to operators.

If you have *valve operating problems,* write us —and a "Philadelphia Engineer" will gladly call.

# Philadelphia Gear Works, INC.

**ERIE AVE. AND G ST., PHILADELPHIA 34, PA.**

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

*Industrial Gears and Speed Reducers*
*LimiTorque Valve Controls*

# CALL ON THE "Specialists" FOR ACCURATE METERING

1,000,000 cfh—
One R-C Positive Displacement Meter to measure large volumes saves foundation costs and possible loss of production space.
4,000 cfh—especially valuable for metering purchased or sold gas, or for proportioning and departmental cost accounting.

The successful performance of Roots-Connersville Positive Displacement Meters has long been proved by large and small industrial plants and public utilities. These users rate them high in such basic essentials as:

**Accuracy**—not affected by pressure, wide ranges in loads or other variables. Absence of valves, vanes and other small parts insures "cash register" accuracy over years of use.

**Capacity**—from 4,000 cfh to 1,000,000 cfh in one unit, with ample ability to absorb overloads.

**Compactness**—smallest made for industrial use in foot-for-foot of capacity. Can be located in otherwise unusable space, thus saving production areas.

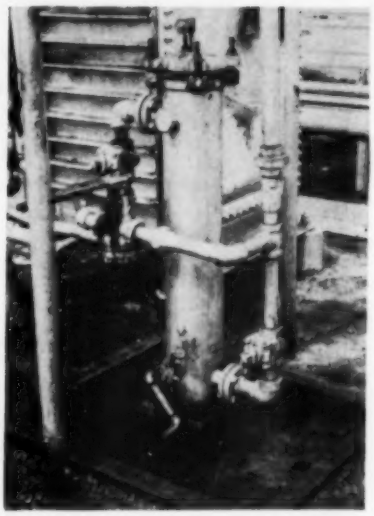
Almost a century of experience in handling gas and air, exclusively, goes into the design and construction of R-C Meters. They're part of the comprehensive line of blowers, exhausters, gas and vacuum pumps and related equipment, which are the products of R-C Specialists, and which are in widest use in industry.

A new bulletin, M-152, gives complete data on R-C Meters, including a handy selection table which simplifies your choice of the right meter to suit your specific application. Your copy will be sent on request.

ROOTS-CONNERSVILLE
*Exclusive Specialists in Handling Gas and Air*

**ROOTS-CONNERSVILLE BLOWER** A DIVISION OF DRESSER INDUSTRIES, INC. 534 Crescent Ave. • Connersville, Indiana


## How to Do It . . .



dation was set above, and vented to, one of the plant sewer lines to ease the problem of waste disposal. The filtering media are cotton bags, similar to those used to filter compressor lube oil. Cleaning of the bags is easily accomplished by turning them wrong side out and washing with a stream of water.

## Scrap Pipe Converted Into Baler Cage for Empty Bags

Two birds with one stone—that's the claim for the combination storage bin and baler shown in the photograph. Scrap pipe was used for construction, and a welder completed the job in a few hours.

Other than the piping shown in the photo, requirements for the baler include a spool of wire affixed to the top right hand corner of the rack. Emptied chemical bags, oil rags, or coveralls are piled into the cage until full. Then wire is pulled from the spool, wrapped around the rags, with a neat tight bale as the end result.

# Forty billion barrels ago—

Measured in years, it is less than a century since Colonel Drake drilled the first oil well, in 1859. Measured in terms of the gigantic American petroleum industry which grew from his pioneering enterprise, the August day when his well spurted forth the long-sought oil was more than forty billion barrels ago.

Two thousand barrels was the output in 1859. About two billion barrels now come yearly from American wells to meet the demands of the modern motor and the varied other uses of petroleum products.

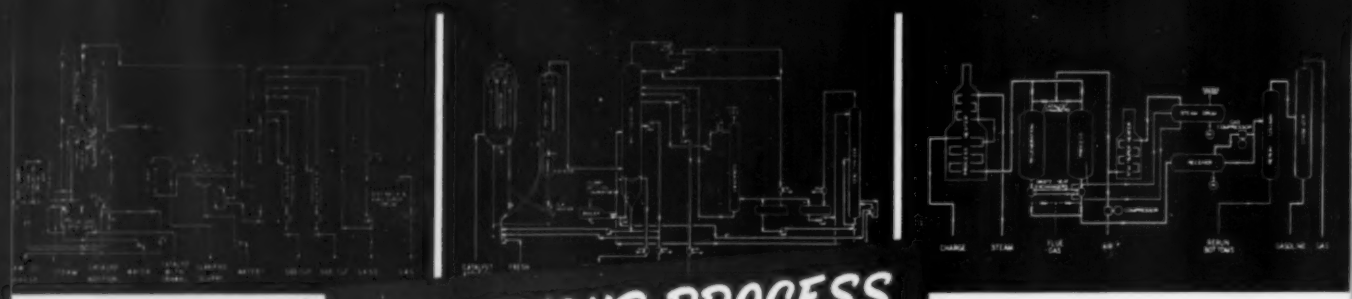
For decades, Sun Ship has played an important part in construction of the refinery equipment . . . fractionating towers, condensers, pressure vessels, machinery and other equipment . . . to meet these demands. The facilities, modern manufacturing methods and skilled personnel at the great Sun Ship plant provide a combination that has consistently shown its ability to serve the petroleum, chemical and petrochemical industries in the task of building a greater America.

**Sun**

**SHIPBUILDING & DRY DOCK COMPANY**

**ON THE DELAWARE** (SINCE 1916) **CHESTER, PA.**

**25 BROADWAY • NEW YORK CITY**



NAME YOUR PROCESS

# National Tube can supply the right pipe and tubes

**IN THE NUMEROUS TECHNIQUES** employed in modern refining processes, pipe and tubing plays an essential and often widely diversified role. That is why the 24 *different* analyses which we can offer in National Seamless Pipe and Tubes are so important.

MANY considerations enter into the selection of refinery pipe and tubes. Different processes. Different production techniques. Temperatures. Pressures. Corrosives. Acids. Atmospheric conditions. Separately, or in combination, they all have some bearing on the pipe and tubing you use.

Here at National Tube — the world's largest manufacturer of tubular products — we have gathered a vast amount of interesting information on the performance of various steel analyses under practically every conceivable condition.

Through research and laboratory experiments; through on-the-scene observations; and by studying actual installations with the men in charge, we have developed 24 different analyses of Still Tubes, Condenser and Heat Exchanger Tubes, and Refinery Piping.

That's why we say: *bring your problems to National Tube.* If conditions at your plant are new to our engineers, you can be sure that we will not make a recommendation without first satisfying ourselves that we have come up with the right analyses for your particular requirements. An inquiry entails no obligation on your part.

**NATIONAL TUBE offers you Seamless Steel Still Tubes . . . Condenser Tubes . . . Heat Exchanger Tubes . . . Refinery Piping . . . in 24 DIFFERENT ANALYSES**

| | | |
|---|---|---|
| Carbon | ¾ Cr, ½ Mo | 5 Cr, ½ Mo |
| Carbon, ½ Mo | 2¼ Cr, 1 Mo | 5 Cr, ½ Mo, 1½ Si |
| ½ Cr, ½ Mo | 2½ Cr, ½ Mo, ¾ Si | 5 Cr, ½ Mo, Ti |
| 1 Cr, ½ Mo | 3 Cr, 1 Mo | 7 Cr, ½ Mo |
| 1¼ Cr, ½ Mo | | 8 Cr, ½ Mo |
| | | 8 Cr, 1 Mo |
| | | 9 Cr, 1 Mo |
| | | 12 Cr, Al |
| | | 17 Cr |
| | | 27 Cr |
| | | 18-8 |
| | | 18-8 Ti |
| | | 18-8 Cb |
| | | 18-8 Mo |
| | | 25-20 |

All National Seamless Tubes are pierced from a solid billet of high-quality steel. This is the one method that removes all doubt concerning uniform wall strength.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
*(Tubing Specialties)*

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

**U·S·S NATIONAL SEAMLESS PIPE AND TUBES**

UNITED STATES STEEL

# [ What's Happening in the Industry ]

## PAD Says Refineries Could Double Naphthenic Acid Output

Oil refineries in the U. S. could practically double their output of high-grade naphthenic acid in the event of emergency, Deputy Petroleum Administrator J. Ed Warren said recently. His statement was based on the results of a survey the Petroleum Administration for Defense has made on output of and potential capacity for naphthenic acid of 180 acid number or higher. (The acid number is based on molecular weight.)

Covering refineries representing about 70 percent of total refinery capacity in the country, the survey indicated that current annual production of this grade of acid totals about 33,600 pounds. In the event of an emergency, however, the refineries could produce more than 32,500,000 pounds of additional acid each year.

## Paris Technicians Honor Egloff By Association Membership

Dr. Gustav Egloff, director of research at Universal Oil Products Company, has been elected an honorary member of the Association Francaise des Techniciens du Petrole, Paris.

**WPRA Shows Appreciation to Tollett—**

**Presentation of a certificate of appreciation for services rendered by R. L. Tollett, past president of the organization, was a highlight of the recent formal meeting of the board of directors of the Western Refiners Association. The meeting was held in connection with the association's 41st annual conference in San Antonio, Texas. Tollett, left, president of the Cosden Petroleum Corporation, Big Spring, Texas, has just concluded his second year as WPRA leader. He received the handsomely illuminated testimonial from Fayette B. Dow, right, WPRA general counsel, Washington, D. C. Roland V. Rodman, center, Oklahoma City, Okla., president of Anderson-Prichard Oil Company, is the newly elected 1953-54 WPRA president.**

### Domestic Refinery Runs and Crude Oil Production of U. S. Companies in 1952

**(Data from all available annual reports of U. S. companies with refinery runs and/or crude production above 10,000 barrels daily.)**

| COMPANY and RANK | CRUDE RUNS TO STILLS | | | CRUDE OIL PRODUCTION | |
|---|---|---|---|---|---|
| | Total Barrels | Barrels Daily | Percent of U.S. | Barrels Daily | As Percent of Runs to Stills |
| (1-A) Standard (N.J.) U.S. Affiliates. Total | 285,114,000 | 779,000 | 11.68 | 405,612 | 52.1 |
| 1. Standard (N.J.) Net Share of U.S. Affiliates | 259,330,398 | 708,553 | 10.62 | 307,724 | 43.4 |
| 72 Percent of Humble O. & R. Co. | 66,300,480 | 181,149 | 2.72 | 251,713 | 139.0 |
| Wholly Owned Subsidiaries | 193,029,864 | 527,404 | 7.90 | 56,011 | 10.6 |
| Esso Standard Oil Co | 185,583,960 | 507,060 | 7.60 | ... | ... |
| Carter Oil Co. | 7,446,000 | 20,344 | 0.30 | 56,011 | 275.3 |
| 2. The Texas Co. | 192,197,466 | 525,129 | 7.87 | 301,926 | 57.5 |
| 3. Socony-Vacuum Oil Co. | 185,702,000 | 507,382 | 7.61 | 218,656 | 43.1 |
| 4. Standard Oil Co. (Indiana) | 185,342,400 | 506,400 | 7.59 | 245,200 | 48.4 |
| 5. Gulf Oil Corp. | 182,118,000 | 497,590 | 7.46 | 223,574 | 44.9 |
| 6. Standard Oil Co. of Calif. | 149,394,855 | 408,183 | 6.12 | 279,574 | 68.5 |
| 7. Shell Oil Co. | 139,632,000 | 381,508 | 5.72 | 262,566 | 68.8 |
| 8. Sinclair Oil Corp. | 138,987,146 | 379,746 | 5.69 | 116,885 | 30.8 |
| 9. Humble Oil & Refining Co. | 92,084,000 | 251,596 | 3.77 | 349,601 | 139.0 |
| 10. Cities Service Co. | 86,735,000 | 236,981 | 3.56 | 106,363 | 44.9 |
| 11. Phillips Petroleum Co. | 79,880,986 | 218,254 | 3.27 | 123,731 | 56.7 |
| 12. Sun Oil Co. | 78,013,865 | 213,153 | 3.19 | 106,003 | 49.7 |
| 13. Atlantic Refining Co. | 64,796,000 | 177,039 | 2.66 | 92,423 | 52.2 |
| 14. Tide Water Associated Oil Co. | 54,946,681 | 150,127 | 2.25 | 95,589 | 63.7 |
| 15. Union Oil Co. of Calif. | 49,840,000 | 136,175 | 2.04 | 91,989 | 67.6 |
| 16. Standard Oil Co. (Ohio) | 43,360,540 | 118,471 | 1.78 | 33,916 | 28.6 |
| 17. Richfield Oil Corp. | 38,383,000 | 104,872 | 1.57 | 57,817 | 55.1 |
| 18. Pure Oil Co. | 37,364,041 | 102,088 | 1.53 | 72,402 | 70.9 |
| 19. Continental Oil Co. | 34,897,000 | 95,347 | 1.43 | 113,442 | 119.0 |
| 20. Mid-Continent Petroleum Corp. | 21,301,193 | 58,200 | 0.87 | 18,908 | 32.5 |
| 21. Skelly Oil Co. | 15,810,850 | 43,199 | 0.65 | 64,949 | 150.3 |
| 22. Sunray Oil Corp. | 14,506,969 | 39,637 | 0.59 | 70,126 | 176.9 |
| 23. The Ohio Oil Co. | 13,774,297 | 37,635 | 0.57 | 92,508 | 245.8 |
| 24.*Plymouth Oil Co. | 13,708,273 | 37,454 | 0.56 | 20,722 | 55.3 |
| 25. Lion Oil Co. | 7,931,703 | 21,671 | 0.32 | 19,163 | 88.4 |
| 26. Deep Rock Oil Corp. | 5,650,000 | 15,437 | 0.23 | 8,209 | 53.2 |
| 27. South Penn Oil Co. | 3,319,986 | 9,071 | 0.14 | 12,053 | 132.9 |
| †Total 27 Companies | 2,122,708,115 | 5,799,749 | 86.95 | 3,254,306 | 56.1 |
| Remainder of Industry | 318,550,885 | 870,358 | 13.05 | 3,007,981 | 345.6 |
| Total, United States | 2,441,259,000 | 6,670,107 | 100.00 | 6,262,287 | 93.9 |

* Through wholly owned subsidiary, Republic Oil Refining Co., which has plant at Texas City, Texas.

† Includes 100 percent of Humble as one company and Standard (N.J.) wholly owned subsidiaries, Esso Standard and Carter, as one company.

## Swensrud Elected Chairman in Gulf Management Changes

At the recent organization meeting of the board of directors of Gulf Oil Corporation, the following changes were made in the company's top management:

J. Frank Drake, after serving the past five years as chairman of the board and the previous 17 as president, now takes a less active role as chairman of the executive committee.

Sidney A. Swensrud, company president since 1948, was elected chairman of the board of directors and thus becomes the chief executive officer.

Wm. K. Whiteford, formerly executive vice president, was elected president and will be the chief administrative officer.

All other officers were reelected. In addition, F. C. W. Paton was named vice president in charge of foreign marketing. He was formerly general manager in charge of the company's marketing overseas.

## Oil Company Reports Reveal Existence of Keen Competition

A study of the lately released annual reports of oil reports reveals the existence of keen competition among refiners.

While companies with refinery runs of less than 10,000 barrels a day account for only 13 percent the total crude runs to stills at U. S. refiners, this amount in the hands of independents can be potent competitively. This 13 percent, only a little more than the thruput of the one company that ranks first, is about 870,000 barrels a day of plant thruput. Scattered over the country, it is a large enough volume to exert strong influence on the markets. See table.

HAVING TROUBLE PUMPING HEAVY OILS?
CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES?

Paracoil

...THEN INSTALL

# TANK SUCTION HEATERS

TO SOLVE YOUR PROBLEMS

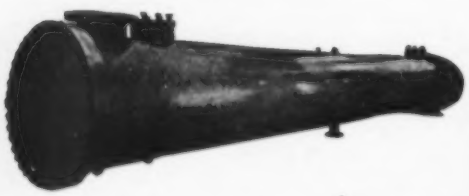
**TANK SUCTION HEATER INSTALLATION**

**The shell is open at the inside end. The oil moves across the heating tubes as it passes through the shell to the suction connection outside the tank.**

In Bulk Oil Terminals and Refineries the world over Paracoil Tank Suction Oil Heaters are licking the problem of economically preheating heavy viscous oils to permit their withdrawal from storage tanks. They are also preheating the lighter grades of fuel oils to their proper delivery temperatures to avoid the costly volume losses incurred when such oils are sold at low temperatures.

**WITH PARACOIL TANK SUCTION OIL HEATERS**

- **You Heat Only The Oil That Is Being Withdrawn From The Tank.** (Thus radiation losses resulting from heating entire tank contents are eliminated.)
- **Overall Steam Consumption And Heating Costs Are Held To A Minimum.**
- **Heater Tube Bundle Can Be Withdrawn For Inspection And Cleaning.** Breaking of oil suction line not necessary.
- **All Piping Connections And Gaskets Are Outside The Tank.**
- **U-Tube Design Permits Free Expansion And Contraction Of Tube Bundle.** Either high or low pressure steam can be used as the heating medium.



**Prompt Shipments!**
Our extensive stocks of tubing and pipe enable us to make quick deliveries to meet your immediate requirements.
*Write for Descriptive Literature*

**SPEED UP DELIVERIES AND CUT OIL VOLUME LOSSES WITH PARACOIL TANK SUCTION HEATERS**

**In addition to the Paracoil Tank Suction Heaters, we also design and fabricate Line Type Discharge Heaters of any capacity. Illustrated is a Paracoil Straight Tube Type Fuel Oil Heater for bulk station service—capacity 2,000 gallons per minute, No. 6 oil, 100°F to 160°F, steam at 15 psig. Weight 12 tons.**

**DAVIS ENGINEERING CORPORATION**

**1060 East Grand Street, ELIZABETH 4, NEW JERSEY**
**30 Rockefeller Plaza, NEW YORK 20, N. Y.**


## [ What's Happening ]

At the same time even keener competition prevails among the 27 or so larger refiners having crude runs of 10,000 barrels a day or more, each always trying and frequently succeeding in boosting business volumes above those of competitors.

The ceaseless competition is further revealed by comparing results for 1952 with those for 1951.

Standard Oil Company (New Jersey) easily retained the No. 1 rating. But The Texas Company moved into second place from fourth, forcing Socony-Vacuum Oil Company, Inc., and Standard Oil Company (Indiana) to drop down one position each into third and fourth place, respectively. Gulf Oil Corporation remained fifth largest in volume of refinery runs.

### Oil Industry Pioneers Named For IPE Grand Old Man Awards

Charlton H. Lyons, Shreveport, La., president of the Independent Petroleum

Crawford

Oberfell

Association of America, will deliver the principal address at opening ceremonies of the 30th Anniversary International Petroleum Exposition. The show opens in Tulsa May 14 for a ten-day stand.

Reeser

Introductory remarks will be made by W. G. Skelly, president of the exposition, and Governor Johnston Murray of Oklahoma.

Exposition officials have estimated the opening day attendance for the $100 million exhibition will be "around 50,000 persons." Approximately 10,000 are expected to be on the grounds for opening ceremonies.

Lyons' talk will follow colorful ceremonies which will include the raising of a giant, 40 x 60-foot United States flag. The flag will be unfurled between two 140-foot rotary drilling masts on the exposition grounds.

Among the special features of the Exposition will be a commemorative ceremony honoring pioneers of the oil industry. It will take place on "Old Timers Day," May 17, near the Drake Well replica on the exposition grounds.

Harry J. Crawford, Emlenton, Pa., has been selected "Pioneer of Pioneers" of the oil industry. As part of the ceremony, gold medal awards will be presented to "Grand Old Man" honorees in each of the six industry divisions. They are: W. L. Connelly, "Grand Old

# Here's a Dragshovel That REACHES For Extra Dirt

The all-hydraulic Bucyrus-Erie Hydrohoe reaches for extra yardage because it provides two separate digging actions. The first is the conventional dragshovel action of the dipper moving through its digging arc. The second digging action is a separate horizontal pull obtained by telescoping the boom. With this special telescope action, operator can peel off the usual waves and scallops at grade level, leaving a smooth, flat trench floor. Also, by extending and retracting boom, move-up on trench cutting has been reduced as much as 40 percent.

The outstanding advantage of telescoping boom plus overall crane compactness and high travel speed makes the Hydrohoe ideal for digging pipe trench at pumping stations and refineries, uncovering pipe line leaks, digging drainage ditches, etc.

## QUICK CONVERTIBILITY TO HYDROCRANE

By actual time test, dragshovel has been converted to crane front end by one man in **less than an hour!** As a crane it's a tremendous man-hour saver handling materials and supplies for supply houses, producers and drillers.

Get the full story on the all-hydraulic Hydrohoe and the Hydrocrane with its many attachments. Send coupon today.

Here is the Hydrohoe in action. Every work function fully hydraulic — boom hoist and swing, dipper dig and dump, boom telescope, outrigger set and retract, and positive dirt ejector.

South Milwaukee, Wisconsin

**BUCYRUS-ERIE COMPANY**
South Milwaukee, Wis.

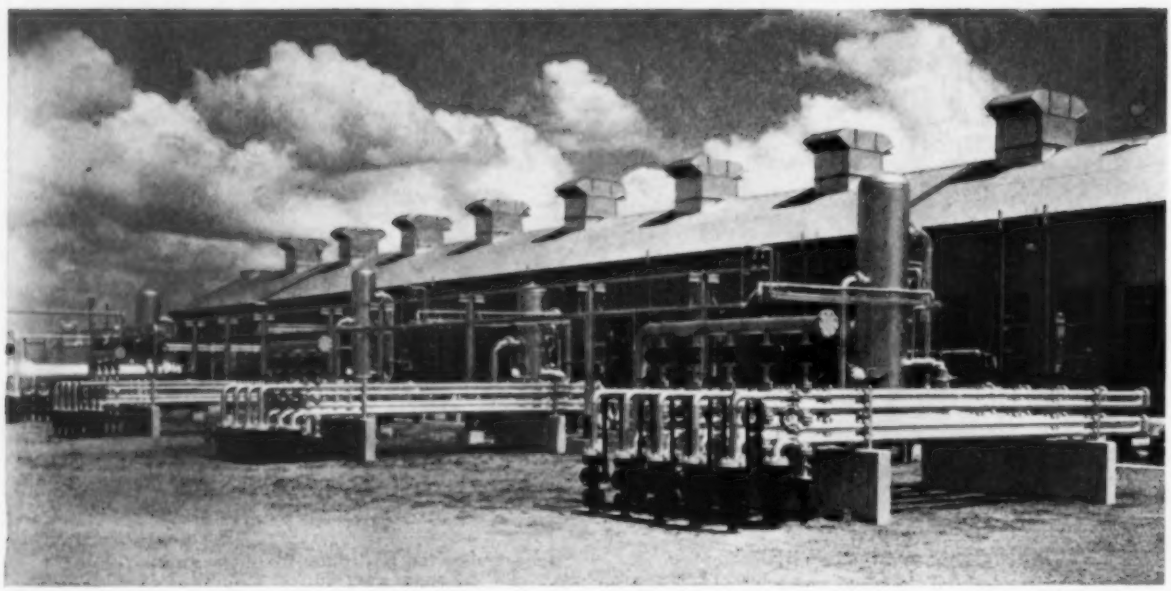
Gentlemen:

☐ Please send me Hydrohoe literature.
☐ Please send me Hydrocrane literature.

Name.....
Title.....
Address.....
City..... State..... 7H53

# Assure Top Efficiency

## in your plant with



## BROWN FINTUBE *Sectional* HEAT EXCHANGERS

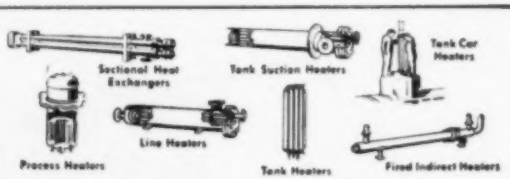
● Avoid the loss in efficiency that results from just a few thousandths of an inch of deposit on the tubes, by using Brown Fintube Sectional Exchangers for every heating and cooling service.

The longitudinal passages of Brown Fintube Sections control the material flow, eliminating baffles and the back eddies that encourage fouling. Their greater heating surface — 2 to 8 times that of bare tubes — permits more BTUs to be transferred at lower temperature per square foot of surface, minimizing "coking" and charring. Brown Fintube Sections are easy to clean — and — by simply manifolding a few extra sections into the unit, one stream after another can be taken off line for cleaning while the rest — always thoroughly clean — carry the unit's full rated capacity, year after year — without any shut-downs.

Efficient heating, is only one of Brown Fintube's many advantages. You'll find full details in our Bulletin No. 512. It will give you ideas.

BROWN FINTUBE

**BROWN FINTUBE CO.**
*Elyria, Ohio*




NEW YORK • BOSTON • PHILADELPHIA • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI • DETROIT • CHICAGO • ST. PAUL • ST. LOUIS
MEMPHIS • BIRMINGHAM • NEW ORLEANS • SHREVEPORT • TULSA • HOUSTON • DALLAS • LOS ANGELES • SAN FRANCISCO • and ST. THOMAS, ONT.

Man of Production"; Edwin B. Reeser, "Grand Old Man of Refining"; Wallace R. Finney, "Grand Old Man of Pipe Lines and Transportation"; Dr. Godfrey L. Cabot, "Grand Old Man of Natural Gas"; Dr. George G. Oberfell, "Grand Old Man of Natural Gasoline"; and Wallace D. Wilson, "Grand Old Man of Supplies and Equipment." D. E. Buchanan, Evergreen, Colo., will serve as master of ceremonies.

The tradition of honoring outstanding senior members of the oil fraternity at the exposition was originated at the 1927 show when John D. Rockefeller, Sr., presented similar awards.

Crawford is now chairman of the board of several oil companies and president of the First National Bank of Emlenton. Connelly has been continuously associated with the Sinclair companies since 1906. Reeser retired in 1943 as president of Barnsdall Oil Company, which was merged into Sunray Oil Corporation in 1950. Finney has held executive positions with several pipe line companies, including president and director of Oklahoma Pipe Line Company. Cabot is president of Godfrey L. Cabot, Inc., Cabot Carbon Company and several other organizations. Oberfell, since his retirement as vice president in charge of research and development for Phillips Petroleum Company, has been active as a research consultant. Wilson is president of Wilson Supply Company, Wilson Foundry and Machine Company and director of the First National Bank in Houston.

Meanwhile at the exposition grounds, activity in preparation of the "World's Fair of the Oil Industry" has been furious. Exposition officials report that over 150 carloads of packaged displays and models of newest types of equipment have already been set up and more arrive daily. And towering above all the activity stands a giant, 80-foot statue of an oil field worker, long recognized as the most familiar symbol of oil.

This voluminous collection is expected to attract observers from around the world. Exposition officials predict that representatives from at least 50 nations will attend the show.

## California Standard Employes Work 2 Million Safe Manhours

The Richmond, Calif., refinery of Standard Oil Company of California has just completed two million manhours worked without a lost time accident. This total was reached in April and is continuing to grow.

Employes of the plant, numbering 3500, have set up an accident frequency

### Patent Digests Available

The Patent Digest in an expanded form is now available on a subscription basis directly from Dr. Heinz Heinemann, 213 Dickinson Avenue, Swarthmore, Pa. This digest will now cover the fields of drilling, exploration, refining, processing and marketing. Petrochemicals will also be carried. For details, those interested may contact Dr. Heinemann directly.


Here's a product that—

- Gives positive pressure relief!
- Saves vapor loss!
- Protects against fire!

BS&B COMBINATION VENT VALVE FLAME ARRESTER

Has all the features of Model VVFA, except arrester bank. Can be a secondary relief valve with higher setting, or primary relief valve on non-flammable materials.

**Patented Cantilever-Type Arrangement** of rubber to metal seating makes for high vapor conservation...gives a tight seal in a hurry to cut off oxygen supply and extinguish flame. And this snuffing action is automatic!

**Safe, Positive Protection** to storage tanks containing flammable material is assured, thanks to exclusive BS&B design. And the high efficiency Vent Valve Flame Arrester has excellent flow characteristics!

**Cleaning is Simple,** since valve bonnet can be left on when taking out arrester bank. Valve stays in service during time arrester is being cleaned. Remember, with Vent Valve Flame Arresters maintenance time is cut in half, cost is cut even lower. Let us tell you how BS&B Vent Valve Flame Arresters may give you a more efficient, economical operation . . . with greater safety!

*This bulletin tells the complete story. Write for it today!*

**Your Free Copy** of Bulletin E-601 will tell you the seventeen outstanding features that make BS&B Vent Valve Flame Arresters your best buy. Or, ask your BS&B man to study your particular requirements. There's no charge, no obligation.

SAFETY BS&B HEADS OUR 60TH YEAR

BLACK, SIVALLS & BRYSON, INC.
Safety Head Division, Dept. 2-N5
7500 East 12th Street
Kansas City 26, Missouri

# Know the pitch!

Specify **SCOVILL** PHOSPHORIZED

**ADMIRALTY HEAT EXCHANGER TUBES**

With Scovill men and methods on your team, you will get plenty of practical, helpful "signals" to long-life heat exchanger tube performance.

Scovill Phosphorized Admiralty Tube (Alloy 363), for example, is *made* differently... hot extruded from CONTINUOUS-CAST billets. As a result, it is *always* uniform in composition and temper; inhibitor content (phosphorus) is *always* at optimum percentage. Such tube shows superior resistance to corrosion and dezincification, especially where contaminated fresh, salt, or brackish waters are used in the circulation system.

Equally important, Scovill provides what many consider to be the most competent and comprehensive Heat Exchanger Tube Technical Service in the field. We make it our business to see that you get the right tube for your application and conditions... selected from the wide range of heat exchanger tube alloys we produce.

Inquiry and an outline of your needs are encouraged. Write on your business letterhead for our 40-page heat exchanger tube booklet. Scovill Manufacturing Company, 99 Mill Street, Waterbury 20, Conn.

**SCOVILL**
**HEAT EXCHANGER TUBE ALLOYS**

•

PHOSPHORIZED ADMIRALTY
ADMIRALTY
ARSENICAL ADMIRALTY
MUNTZ METAL
NAVAL BRASS
RED BRASS, 85%
DEOXIDIZED COPPER
ARSENICAL COPPER
COPPER NICKEL, 10% & 20%
CUPRO-NICKEL, 30%
CUPRO-NICKEL, 30% (High Iron)
ALUMINUM BRASS
ALUMINUM BRONZE, 5%
DUPLEX TUBE

SCOVILL

*"You can't buy better Brass"*

89C89

rate for this year of 0.86 accidents per million manhours worked. These figures compare very favorably with the national average for the petroleum refinery industry of 7.17 accidents per million manhours worked in 1951.

While the accumulation of two million manhours without serious injury is rare in the industry, this is not a first for the Richmond refinery, which exceeded 2,700,000 hours early in 1950.

## Catalytic Construction Names George Temple Vice President

George E. Temple has been appointed vice president and general manager of Catalytic Construction of Canada, Ltd. He succeeds Gordon R. Henderson, who resigned to become manager of the new 15,000-barrel-a-day refinery of Sun Oil Company. Both Catalytic Construction and Sun Oil are located at Sarnia, Ontario, Canada.

Temple

Prior to joining Catalytic, Temple was associated with Anglo-Iranian Oil Company, Ltd., for 16 years. He held various positions with AIOC in that time, becoming in 1947 assistant works manager in charge of personnel at Abadan. He continued in this capacity until he left the company in 1952 following nationalization of the properties by the Iranian government.

## Allen Named Superintendent at Cities Service Blackwell Plant

Cities Service Oil Company (Del.) has named Frank M. Allen district superintendent in charge of the company's gasoline plant near Blackwell, Okla. On the new superintendent's staff will be Guy W. Duren of Wichita, Kan., who will supervise operations, and F. P. Dyer of Hutchinson, Kan., who will supervise maintenance.

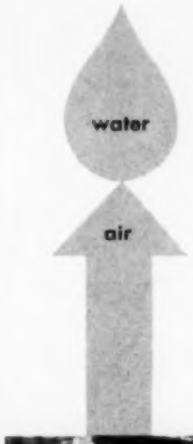
## American Institute of Chemists Gives 1953 Honor Scroll to Mark

Dr. Herman Mark, head of the division of Polymer Chemistry, Polytechnic Institute of Brooklyn, will receive the 1953 Honor Scroll of the New York Chapter of the American Institute of Chemists. The presentation will be made at the Chapter's annual meeting in the Hotel Commodore, May 21, 1953.

The citation to Dr. Mark reads: "As scholar and humanitarian, teacher and expositor, scientist and researcher, you have given lavishly to young and old throughout the world. Beloved by students and colleagues, your adopted country proudly acclaims you for the distinction you have brought."

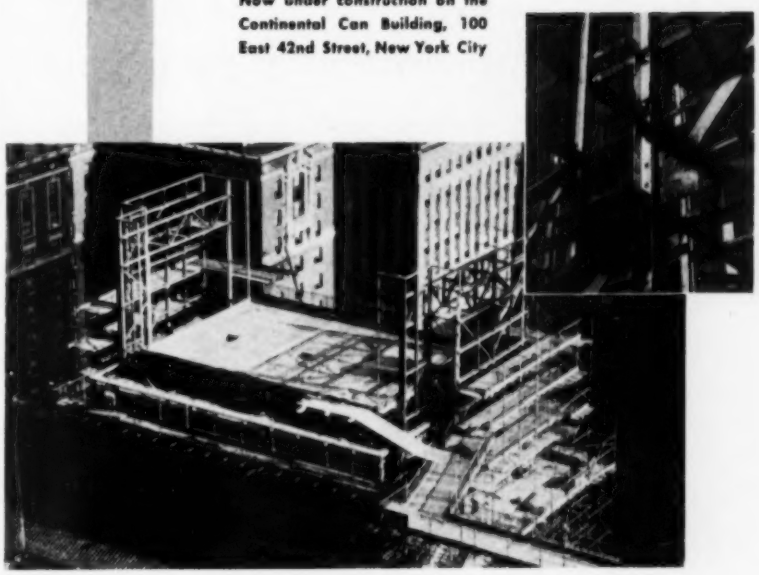
## CNGA to Present Annual Award

An annual award will be made "in recognition of distinguished service in the advancement of the California Natural Gasoline Association," according to an announcement by Warren H. Kraft, CNGA president. It is planned that the award will be made for the first time


**New York's largest all aluminum water cooling tower**

Now under construction on the Continental Can Building, 100 East 42nd Street, New York City



When Zimmermann & Luks, 500 Fifth Avenue, New York City, were employed as consulting engineers to air condition the offices of the Continental Can Company, they found the design of the building was such that the weight of a steel cooling tower of sufficient capacity, would be too great a load for the structural members of the building.

It was decided that an all aluminum construction was necessary and Zimmermann & Luks chose the Water Cooling Equipment Company to design, fabricate and erect an aluminum tower. All angles, channels, gusset plates, bolts and nuts, and the basin are constructed of aluminum. The only major parts of the tower not made of aluminum are the redwood fill, the redwood drift eliminators, the fans, motors, and gears.

In this manner a difficult engineering problem was solved. When you have unusual water cooling tower problems, choose Water Cooling Equipment Company for design, fabrication and erection.

Manufacturers of various types and sizes of mechanical draft and atmospheric cooling towers.

SEE OUR CATALOG IN SWEETS

Architectural
Industrial construction
Plant engineering

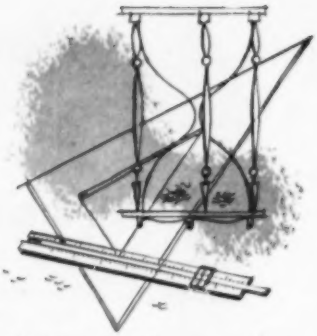
**Water Cooling EQUIPMENT COMPANY**

WCEC

MAIN OFFICE • 8601 New Hampshire Ave. • St. Louis 23, Mo.

*Fabricating Plants:* St. Louis, Mo. • Arcata, Calif. • Houston, Texas

REPRESENTATIVES IN THIRTY-SEVEN PRINCIPAL CITIES



*Years of Design Experience being put to work*

In the two years since our Engineering Division 'hung up its shingle' many interesting and diversified projects are either in operation or nearing completion... projects for the production or recovery of such products as:

* **naphthalene**
* **aromatics**
* **polymerization**
* **synthetic methanol**
* **coal tar products**
* **acetic acid**
* **ethanol**

No narrow or limited experience could possibly have handled the design problems involved. Contributing to this two years of teamwork are individual plant and unit design experiences ranging from a minimum of ten years to well over thirty. This composite of individual experiences, welded into a well-balanced team and complemented by specialists in power, steam, hydraulics, electricity, construction and other phases, is at your service.

Engineering

Design and Construction of Process Plants

•

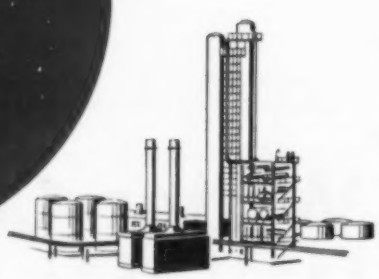
Design and Construction of Process Units

•

Process Evaluations

•

Economic Studies



**BADGER MANUFACTURING COMPANY**

230 BENT STREET, CAMBRIDGE 41, MASS. • 60 EAST 42nd STREET, NEW YORK 17, N.Y.


## [ What's Happening ]

at the association's Annual Fall Meeting in October, 1953.

The purpose of this award, said Kraft, is not only to recognize the outstanding work of younger men but to stimulate their interest in the continuance of the activities of CNGA. In making the award, organizational work, committee service and leadership will be considered. It is not a prerequisite that the man be a scientist. Nominations for the award will be made by the association's individual members.

### NGAA Presents Hanlon Award to Buchanan at Houston Meeting

The Hanlon Award, highest honor in the natural gasoline industry, was conferred recently on Darst E. Buchanan, president of Hiwan Oil & Gas Company, Houston. The presentation was made at the 32nd Annual Convention of the Natural Gasoline Association of America held in the Rice Hotel, Houston.

Buchanan is the seventeenth recipient of the Hanlon Award, which is conferred each year by NGAA for outstanding service to the natural gasoline and cycling industries. Donor of the award is E. I. Hanlon, chairman of the board of the National Bank of Tulsa, and a pioneer in the natural gasoline business.

The presentation was made by NGAA President John F. Lynch, president of La Gloria Corporation, Corpus Christi. The citation read in part: "The natural gasoline industry owes much to this man's long and sustained efforts to expand the markets for the products of its plants. Few men have even been as active in this field and none has been more aggressive. He began his natural gasoline selling in 1918 . . . Though primarily interested in marketing, he took an active part in the development of technical standards for testing and manufacturing, activities which stimulated the production of more stable and more marketable products."

### Texas College Issues Program of Gas Technology Short Course

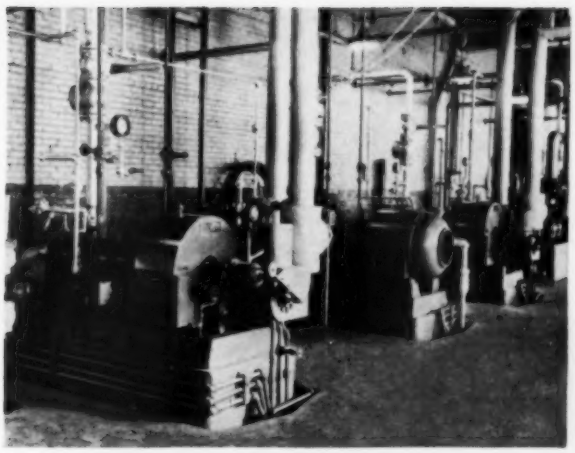
The preliminary program for its Eighth Annual Short Course in Gas Technology to be held May 27-29 has been issued by The Texas College of Arts and Industries, Kingsville, Texas.

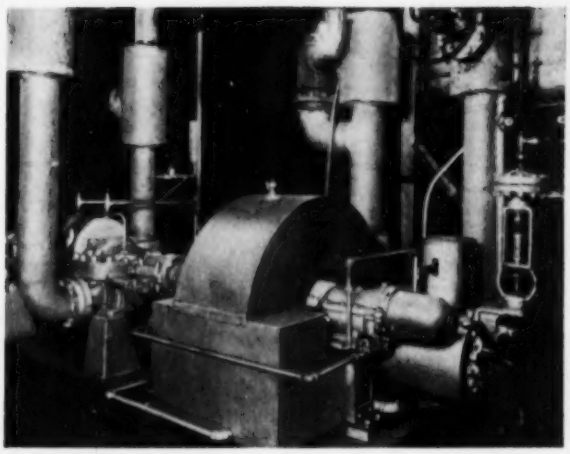
This course, sponsored by the Southern Gas Association, is styled so that once a year technical developments within the industry are presented through classroom lectures and discussion to those who have adequate engineering background in the technical problems of production, transmission or industrial utilization of natural gas.

### Widdell Reelected President at McKee Organizational Meeting

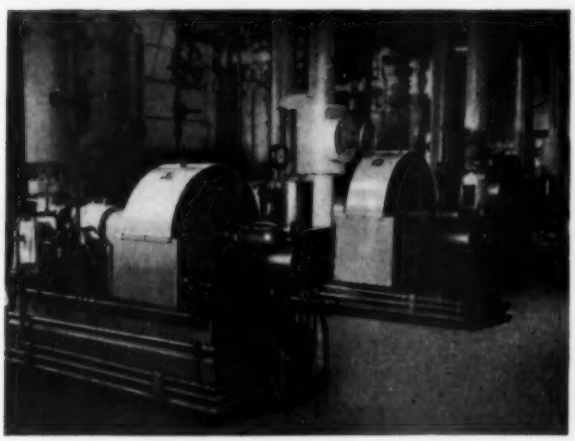
Arthur G. McKee & Company recently elected officers at an organizational meeting following a stockholders' meeting. Reelected were H. E. Widdell, president; Wm. A. Haven, vice president; H. R. Moorhouse, secretary; J. Krumhansl, treasurer; and C. H. Ganzenmueller, assistant treasurer.

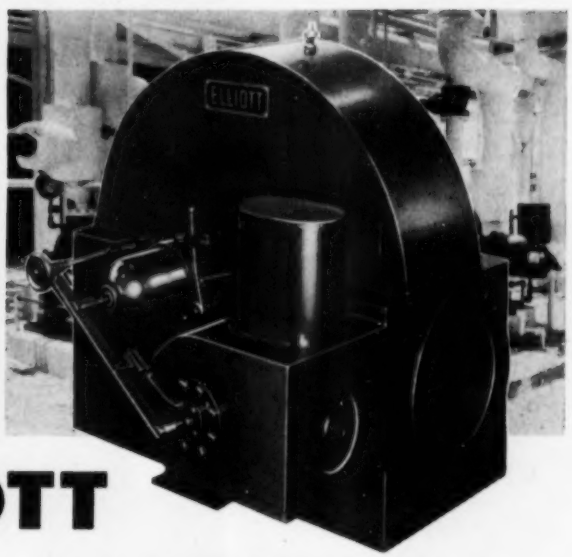
The board also elected a new vice president, Myran J. Livingston, who will





# Because the Industry demands RELIABILITY






## —everywhere ELLIOTT YR TURBINES

One plant may have a dozen—another, twenty or so—a third, sixty or more. When these turbines go into a plant, their simple maintenance, easy adaptability, and above all, their unquestioned reliability, soon result in repeat orders wherever plant requirements demand further mechanical drive units. "Put in Elliott turbines and forget your troubles" is the usual sound advice one plant manager gives another.

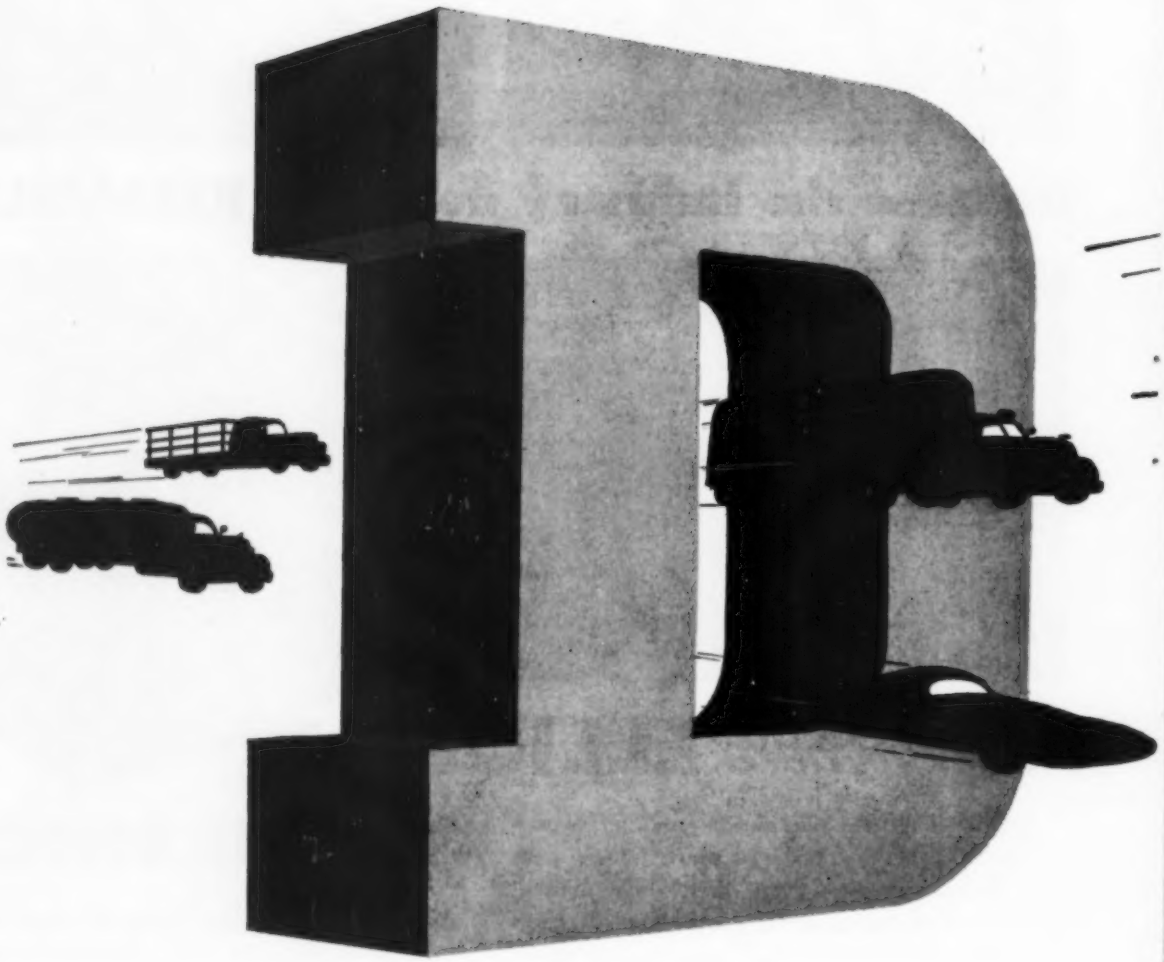
Consider too, the advantages of broad standardization in YR turbine parts, greatly reducing parts inventory. Using the same basic turbine, six different types of governors may be applied to any one of five different frame sizes. These turbines cover a range up to 2000 hp and 7000 rpm.

You can get the turbines you want in the YR line. See your local Elliott engineer or write Elliott Company, Jeannette, Pa.

**ELLIOTT Company**

**STEAM TURBINE DEPARTMENT**

H3 6



## DAVISON DEPENDABLE CATALYSTS BUILD BETTER MOTOR FUEL

The operating efficiency of synthetic fluid-type cracking catalysts is important. This operating efficiency can be assured by uniformity of physical characteristics and chemical purity. Davison's production of microspheroidal (M-S*) is tops in uniformity . . . providing all users with a highly efficient synthetic fluid-type cracking catalyst. Your requirements can also be supplied in ground (DA-1*) form. Write for further descriptive information. Experienced Davison Field Service Engineers backed up with complete laboratory testing facilities are part of Davison's service.

*T.M.T.D.C.C.

*Progress Through Chemistry*

**THE DAVISON CHEMICAL CORPORATION**

*Baltimore 3, Maryland*

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

For high-pressure, high-temperature service (as well as sub-zero duty), Chapman makes steel valves in a range of series from 150 to 2500 lb . . . in gate, globe, angle and check types . . . in steels of many different analyses and with suitable trim to resist corrosion and erosion.

Chapman Steel Valves are accurately machined and finished, designed to ASA and API ratings, and may be furnished with flanged or welding ends. These valves can be equipped for any type of operation . . . hand, gearing, hydraulic cylinder or Chapman motor unit as shown in illustration. So for all standard and any special Steel Valves, check with Chapman *first*. Meanwhile, write for Catalog 20.

**THE CHAPMAN VALVE MANUFACTURING COMPANY**
INDIAN ORCHARD, MASSACHUSETTS

direct the activities of the company's petroleum refining division.

## Former Sohio President Joins Investment Firm as Consultant

Earl D. Wallace, who recently resigned as president and a director of Sohio Petroleum Company and as a vice president and director of The Standard Oil Company (Ohio), has become a consultant to Dillon, Read & Company, Inc., on oil and gas matters.

Wallace

Before joining Standard (Ohio) in 1942 as manager, land and production, he was with Petroleum Exploration Company and Wiser Oil Company. He was also president of People's Gas Company of Kentucky. He served on the Petroleum Industry Production Committee by appointment of the Petroleum Administrator for War.

## Survey Reports Upward Trend In Gasoline Octane Ratings

Gasoline octanes throughout the country reflect a general trend upward, according to the quarterly gasoline survey for April issued by E. I. Du Pont de Nemours & Company, Inc.

While the number of cities reporting premium-grade octane ratings averaging 90 or higher dropped from 38 to 36 this month, the April figure still represents a net gain of nine cities over one year ago. At that time there were only 27 cities falling in the 90 and above grouping.

The most striking gain was registered in regular-grade fuel, with 24 cities reporting an average octane rating of 85 or higher as compared with only 13 a year ago, and 20 last January. The survey also shows no cities where the regular-grade average was below 80 octanes.

Boston nosed out Cleveland and Baltimore for highest premium-grade fuel with an average of 92.9.

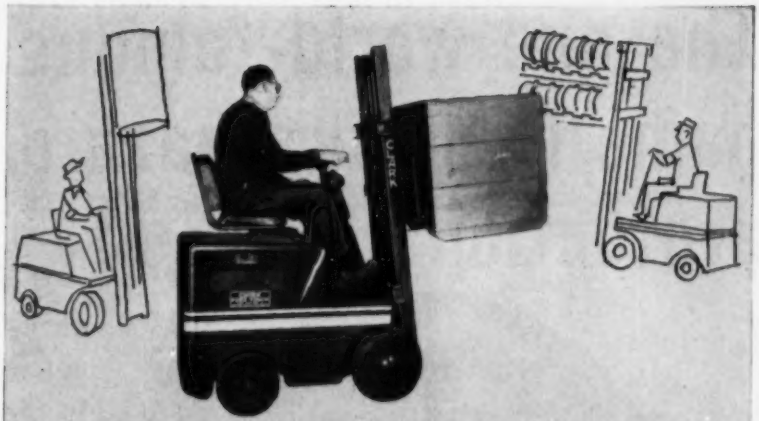
Baltimore placed first in highest regular-grade fuel with an average of 88.0.

## NACE Inter Society Committee To Compile Corrosion Glossary

The Inter Society Corrosion Committee, which now comprises 32 affiliated technical organizations interested in and doing corrosion mitigation, is compiling a glossary of corrosion terminology. Hugh P. Godard, Aluminum Laboratories, Ltd., Kingston, Ont., chairman of the committee, said two new members were added during the year ending March 15.

## Ott Succeeds Wade as Officer In French Chemistry Society

Dr. Emil Ott, director of research for Hercules Powder Company of Wilmington, Del., has been elected president of

WHICH POWER TYPE IS BEST FOR YOU?

...electric, gas, diesel or L.P. gas?

No two jobs are exactly alike, so there's no such thing as one "best" power type. Which type is best *for you*?—that's the important question. The only person who can give a really *unbiased* answer is one who knows them all, and knows where they fit.

That's your local CLARK Dealer. He carries electric, gas, diesel and L. P. gas units—and he's got no ax to grind for any one. His object is to provide the one that's best for you. For example, careful application analysis often proves that *electric* trucks are best for certain jobs because of these advantages:

★ Economical operation on low-cost electric power

★ Long life, less maintenance—electrics have fewer, simpler moving parts

★ Smooth, vibration-free handling of fragile loads, less wear on truck

★ Quiet, clean operation

Which power type is right for you? No matter what it is, you'll find it in the CLARK line of quality handling equipment. You'll always be right when you buy from CLARK.

1903 1953 CLARK EQUIPMENT

WHEN THE ANSWER IS *Electric* CLARK ELECTRICS ARE THE ANSWER ...Here's why:

1 Better battery efficiency—users report more work per amp-hour with CLARK.

2 Greater stability—safer for load, safer for operator.

3 Faster acceleration, greater speed—gets more work done, covers more ground.

4 Safer, smoother stops—with CLARK's positive-controlled, reverse torque braking.

5 "Application-engineered"—for special requirements, CLARK provides custom engineering.

CLARK ELECTRIC, GAS, DIESEL, L.P. GAS FORK TRUCKS AND POWERED HAND TRUCKS · INDUSTRIAL TOWING TRACTORS

INDUSTRIAL TRUCK DIVISION • CLARK EQUIPMENT COMPANY • BATTLE CREEK 161 MICHIGAN

Please send: ☐ Condensed Catalog ☐ Driver Training Movie ☐ Have Representative Call

Name _____

Firm Name _____

Street _____

City _____ Zone _____ State _____

AUTHORIZED CLARK INDUSTRIAL TRUCK PARTS AND SERVICE STATIONS IN STRATEGIC LOCATIONS

# The one world-famous name in oil fire hazard protection

Throughout the world, more major oil fires have been put out with Pyrene* than any other air foam equipment. Whether *your* fire hazard is in Texas or Tasmania—and whatever it may be—Pyrene can provide you with a built-in air foam system that precisely meets your requirements. For complete information, or the help of a Pyrene engineer, write us today.

*T.M. Reg. U.S. Pat. Off.

Pyrene AIR FOAM

**PYRENE MANUFACTURING COMPANY**

682 Belmont Avenue, Newark 8, New Jersey

Affiliated with C-O-Two Fire Equipment Co.

The Pyrene Company Limited, England  Pyrene Manufacturing Co. of Canada, Limited




the American section, Societe de Chimie Industrielle. He succeeded Dr. Worth Wade, assistant to the president of American Viscose Corporation. The parent society is sponsoring the 26th International Congress of Industrial Chemistry in Paris in June.

## PAD Says Alkylates Program Progressing But Still Short

More alkylate facilities will be needed even if all contracts now in tentative stages are signed, a PAD official has said. He reported that one alkylate facilities contract is in the signing stage, four other are "virtually certain" and several other prospects are "good."

He said it appeared that almost all of the planned projects would be privately financed, rather than through the government's recent offer to provide financing where necessary. He said companies were considering the government financing only as a "last resort."

In line with the need for more alkylate facilities, the Office of Defense Mobilization has established a 30,000-barrel-a-day alkylate expansion goal. This target is similar to the one set by PAD and Armed Services Petroleum Purchasing Agency.

Principal purpose of ODM's formal goal was to provide a yardstick for approving alkylate projects for fast tax write-off. Currently, permission is being given for a five-year write-off at 100 percent of the facilities, whereas percentage for other petroleum projects ranges from 25 to 90 percent.

ODM said the expansion goal was in addition to plants already built or under construction, such as the three plants with total capacity of 5800 barrels a day authorized by facilities contracts.

Contracts reported by PAD to be in the final negotiation stages have a combined capacity of 6600 barrels a day. This would leave the expansion 23,400 barrels a day short of its goal.

## Cities Service Announces Two Elected to Executive Positions

Election of J. A. Cleverley and Reese H. Tucker as vice presidents has been announced by Cities Service Oil Company (Del.).

Cleverley, formerly manager of Oil Production, was also elected a director of the company. Tucker, formerly manager of the Land-Geological division, was elected to the board several months ago.

## Third and Fourth Refineries Closed in Mid-Continent Area

High operating costs in the face of relatively light demand and low prices for distillate and residual fuels have continued to force the closure of small Mid-Continent refineries.

Third and fourth of the refineries to be shut down were Inland Refining Company's 2000-barrel-a-day plant at Palestine, Texas, and the 5000-barrel-a-day refinery on the W. T. Waggoner estate at Electra, Texas.

Earlier shutdowns were Bareco at Wichita, Kan., and Consumers Cooperative Refining Association's plant at Levelland, Texas.

Inland is offering its plant equipment for sale and has said there is "no hope

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION
# COPPER ALLOY BULLETIN
Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

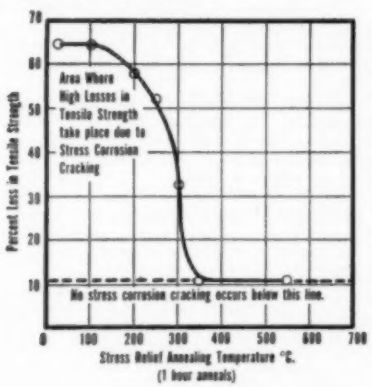
## Preventing Stress Corrosion and Season Cracking of Condenser and Heat Exchanger Tubes

### PART II

As mentioned in last month's Copper Alloy Bulletin, stress corrosion and season cracking generally result from the combined effects of the presence of ammonia in the atmosphere, the composition of the alloy and the magnitude of the stresses present in the tubing. The absence of any one of these factors prevents stress corrosion and season cracking from taking place. Consequently, the reduction or removal of stresses in the tubing is a preventive measure.

This can be effected by stress relief annealing. A temperature in the neighborhood of 200°C or higher is required for reduction or removal of such stresses. The stress relief annealing temperature varies with the alloy and extent of cold working.

Effect of Stress Relief Annealing Temperature on Stress Corrosion Cracking (Alternate Immersion in 15% normal $NH_4OH$ Solution, 50% Hard Leaded Brass Tubing).




It is evident from this laboratory test that relief of stress begins at temperatures above 100°C and apparently is not complete until recrystallization occurs.

In the manufacture of condenser tubes such as Admiralty, Muntz, Aluminum Brass, and Aluminum Bronze, the tubes are cold drawn to the finished size. This is followed by annealing to remove stresses and to recrystallize the metal for the formation of the grain size called for in A.S.T.M. Specification B-111-52.

Copper and Arsenical Copper tubes are supplied in any one of the following tempers:

Light Drawn Temper
Hard Drawn Temper
Hard Drawn Temper End Annealed.

90-10 Cupro Nickel tubes may be supplied in either light drawn temper or annealed temper.

Copper, Cupro Nickel and Red Brass are more resistant to stress corrosion cracking than Admiralty, Muntz, and Aluminum Brass. The relative order of merit is as follows:

Copper
70-30 Cupro Nickel
80-20 Cupro Nickel
90-10 Cupro Nickel
Red Brass
Aluminum Bronze
Admiralty
Aluminum Brass
Muntz Metal.

The annealed condenser tubes are required by the A.S.T.M. specification to stand without cracking an immersion for 30 minutes in a 1 per cent mercurous nitrate solution. However, this test is not required for copper, arsenical copper and copper-nickel tubes because they are resistant to cracking in this solution.

#### Effects of Improper Handling

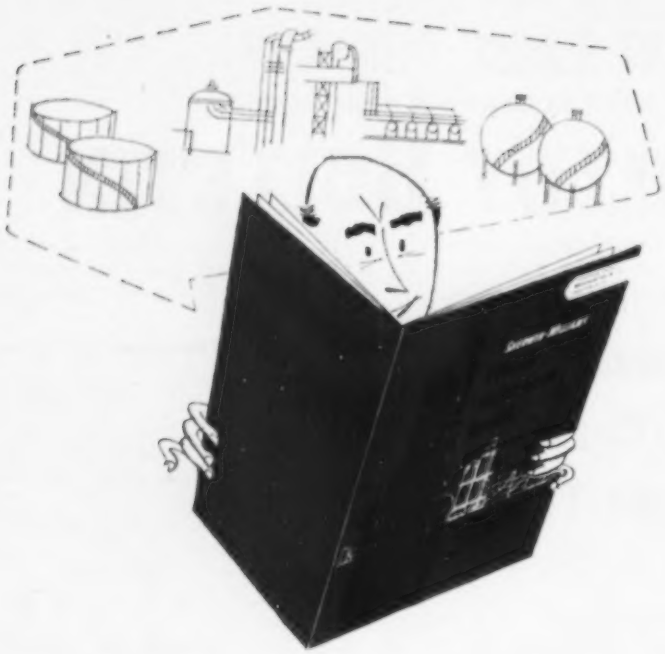
The ends of tubes may be injured through excessive expansion and hardening during roller expansion into the tube sheets. Expanding into enlarged or oversized holes in the tube sheets will stretch the circumference of the tube more than normally and may result in high residual stresses at the end of the roller-expanded section.

The expanding of the tube beyond the thickness of the tube sheet may also leave the metal with high residual stresses. In most environments these stresses will be of no serious consequence, but if ammonia, mercury, or mercury salts come into contact with the stressed brass, cracking may result soon after exposure. The most common source of ammonia emanates from the decomposition of slime on the tube surface particularly during a stagnant period such as when the condenser is not in operation. Trouble from this source during equipment shutdown can be minimized by thoroughly drying out the condenser tubes by blowing warm air through the unit or chemical treatment (such as chlorination) for the removal of slime or prevention of slime.

#### Effect of Liquid Metal on Stressed Tubes

Rapid intercrystalline penetration of brass and copper alloys by liquid metals such as mercury and molten solder may cause cracking. This is occasionally encountered in condenser and heat exchanger tubing. Such penetration can occur in a matter of seconds when the tube is bent or otherwise deformed or stressed before or during contact with the liquid metal. Liquid mercury sometimes finds its way into heat exchangers from mercury salts, originally present in certain crudes or from pressure measuring or control devices using mercury.

Bridgeport's Corrosion Laboratory is constantly investigating the behavior of metals and alloys under a wide range of conditions. Get in touch with the Bridgeport office nearest you for assistance in solving your condenser tube problems and meeting your special requirements. (9775)



# quick answers

## to refinery painting problems

### new guide tells WHAT paints to use WHERE!

Here's practical, convenient help in selecting the right refinery finishes—for decoration and protection of all types of surfaces, from floors to refractionating towers. It's the most complete book on the subject Sherwin-Williams has ever published.

An important feature is a 6-page check chart, which tells *at a glance* what finishes to use for each refinery structure, for each structural material. The recommendations are based on extensive refinery applications through many years, under all types of operating conditions. Included are suggestions on proper surface preparation, steps to take in painting, what to avoid. It's fitted to your needs, to your methods.

Ask for your copy. Write for Brochure A-770. Or write The Sherwin-Williams Co., Petroleum Division, Cleveland 1, Ohio.

**SHERWIN-WILLIAMS**
**PETROLEUM FINISHES**



of Inland ever operating the plant again." Low prices for fuel oils and rail rates were given as the cause for the plant's closure.

John Biggs, manager of the Waggoner properties, announced Waggoner would close its Electra plant sometime during June. The plant, according to Biggs, has been able to make only one grade of gasoline: 84-octane research regular. This, he said, put the refinery at a disadvantage, since premium gasoline had to be bought from other sources.

Meanwhile, Phillips Petroleum Company got into the shutdown act with the announcement that its Spokane refinery will be closed next October.

## New Positions and Divisions Created by Sun Oil Company

Sun Oil Company has created several new staff positions and six new divisions within its Research and Development department.

Dr. Charles L. Thomas, formerly manager of the Research Laboratory, will be associate director of the department in charge of all line activities.

Three new positions as assistant directors will be filled by Norman Thompson, formerly assistant superintendent of Sun's Marcus Hook, Pa., refinery; John G. Moxey, Jr., formerly manager of Automotive Laboratory; and James I. Harper, formerly chief of the Process Development section, Development Laboratory.

The office of the director and the three assistant directors will be located in Sun's general office in Philadelphia while the associate director will headquarter at Marcus Hook.

The following appointments were also announced by Dr. J. Bennett Hill, department director:

W. Herman Barcus, formerly manager of the Development Laboratory, will be manager of a new Products Development division with headquarters at Marcus Hook, handling all development work on products.

Earl M. Honeycutt, formerly of the Process Development section of the Development Laboratory, will manage the new Process Development division, with headquarters at Marcus Hook.

Dr. Robert M. Kennedy, formerly of the Research Laboratory, has been appointed manager of the Basic Research division with headquarters at Norwood, Pa.

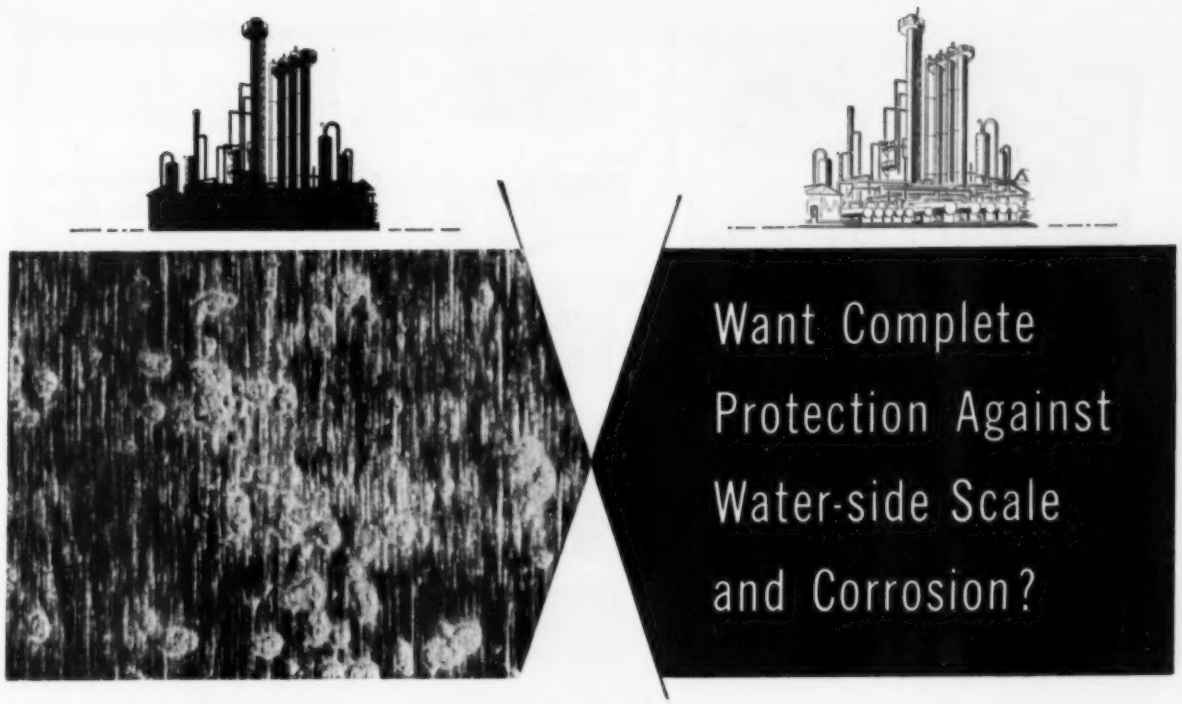
Stewart S. Kurtz, Jr., has been named manager of the Analytical division, heading both analytical research and analytical service. His headquarters will be at Marcus Hook.

William A. Casey, formerly chief of the Technical Service section of the Development Laboratory, will manage the Technical Service division at Marcus Hook.

J. Harold Perrine, formerly administrative associate, has been appointed manager of the Administrative division and will bring together all of the administrative and non-technical service functions of the department.

## Socony Names Vice Presidents

Clark S. Teitsworth and Herbert Willetts were elected vice presidents of Socony-Vacuum Oil Company, Inc., at a recent directors meeting. Both men



# Want Complete Protection Against Water-side Scale and Corrosion?

One of the most difficult problems in corrosion control of cooling water systems is the continuance of pitting and tuberculation. But these troublesome conditions can now be eliminated quickly and effectively with the Betz Dianodic* method of corrosion inhibition.

For example, a midwestern oil refinery with a circulation rate of 40,000 gallons per minute employed "conventional" chromate treatment of the cooling water system. Inspection after 10 months operation showed satisfactory control of scale and general corrosion, but pitting and tuberculation was so serious that it was necessary to "fill-in" the end-around baffles by welding.

After a thorough engineering survey, Betz Engineers recommended the new Dianodic method of cooling water control. Here's what happened: After another 10 months operation, test specimen data showed average penetration values were reduced to 0.001 inch per year. Of greater importance, the maximum depth of the infrequent pits amounted to only 0.02 inch per year. And, the welded baffle ends were in perfect condition with the original welding marks clearly visible!

*Betz Service Mark*

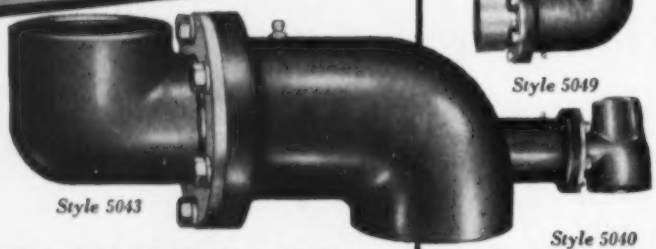
The Dianodic method, developed by Betz Engineers, is a system of combining two anodic inhibitors in such a way as to *effectively eliminate* pitting and tuberculation and at the same time provide protection against general corrosion and scale. It is just one of the many advanced developments produced by Betz . . . the result of sound engineering and progressive research in water conditioning for over a quarter of a century. We'd be pleased to show you how you can obtain similar results in *your* plant. Write today, there's no obligation of course. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Penna. In Canada: BETZ Laboratories Limited, Montreal 1.

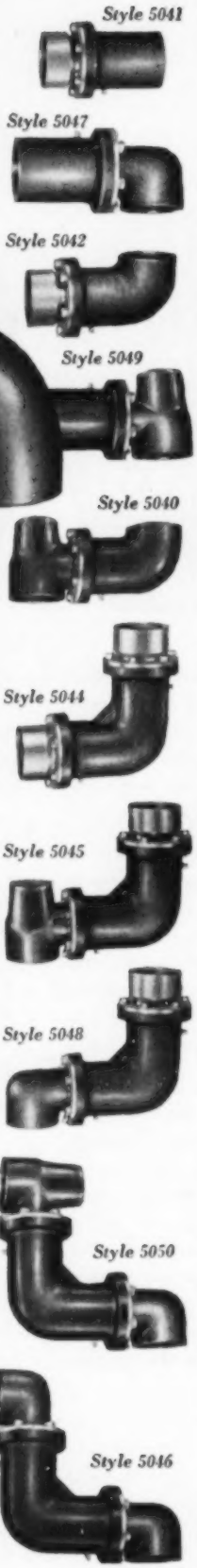
*Betz Technical Paper No. 125 gives full details of the Dianodic Method. May we send you a copy?*

**BETZ**

CONSULTANTS ON ALL WATER PROBLEMS

# BARCO SWING JOINTS




## FOR LOADING AND UNLOADING LINES

BARCO'S new, attractively priced, all-steel ball bearing *Swing Joints* are designed specifically for refinery *service* on loading or unloading lines handling gasoline, oil, lube oil, LP gas, petro-chemicals, and other fluids.

**MANY STYLES**—The Barco line is complete with single swing, double swing, and counterbalance styles to meet every need! Sizes 2", 2½", 3", 4".

**BALL BEARING AND O-RING EQUIPPED**—In Barco Swing Joints, the ball bearings do not fall out when joints are taken apart! Long bearing provides adequate pipe support. *Special O-ring seal eliminates frequent gasket replacement and insures leakproof service* over wide temperature range, −40° F. to +225° F.

**SIMPLE CONSTRUCTION**—Joints can be disassembled for inspection without disconnecting piping. O-rings are easily renewable in the field.

**ENGINEERING RECOMMENDATION**—Barco will be glad to give you detailed recommendations on joints to use and suggested arrangements for complete loading and unloading assemblies.

**NEW!**

**Send for a copy of new Catalog No. 400 containing complete information on Barco Swing Joints. BARCO MANUFACTURING CO., 542F Hough St., Barrington, Ill.**
**(A Chicago Suburb)**

*BARCO—The Only Truly Complete Line of Flexible Ball, Swivel, Swing, and Revolving Joints*


## [ What's Happening ]

have been directors: Willetts as executive in charge of domestic marketing and Teitsworth as executive in charge of manufacturing.

### Private Industry May Purchase Government Synthetics Plant

Five private companies have indicated an interest in operating the government-owned synthetic fuels demonstration plant at Louisiana, Mo., which is scheduled to be closed. The Interior Department is closing it for economy reasons because it feels the plant has served its purpose.

Interior Secretary McKay has said that the plant has "produced its maximum" in gasoline from coal studies and that further tests would be made in the Bureau of Mines laboratories. Closing of the plant, he said, will save the government $10,000 daily. He said he would do all he could to get the plant into private industry through negotiation.

Meanwhile, some bureau officials said privately that they felt the government action in closing the plant would slow developments in coal hydrogenation.

Later, a top oil industry official voiced skepticism over the value any company would derive by purchasing or leasing the plant. He said the plant appeared too small to be operated on a commercial basis and that it was probably too large and expensive to be used only as a laboratory.

John L. Lewis, president of United Mine Workers, is protesting the McKay decision and asking for a delay in the matter.

The Rifle, Colo., oil-shale facilities apparently will be allowed to continue, the House having approved funds for its operation for one year. The Senate is yet to act on both plants.

### Standard Oil Development Makes Synthetic Jet Engine Oil

A synthetic jet engine lubricant, required to meet the needs of the new highpower jet aircraft, has been developed by Standard Oil Development Company in association with its affiliated research laboratories in England.

Specifications in the development of the new lubricant required an oil to lubricate highly stressed gears and bearings at high speeds and over an extreme temperature range of from below —65 F. to more than 450 F.

The present Standard Oil Development synthetic jet engine oil is not derived entirely from petroleum-source chemicals. It is recognized as only the first step in the evolution of synthetic jet engine oils.

### Lummus Offers Shell Process

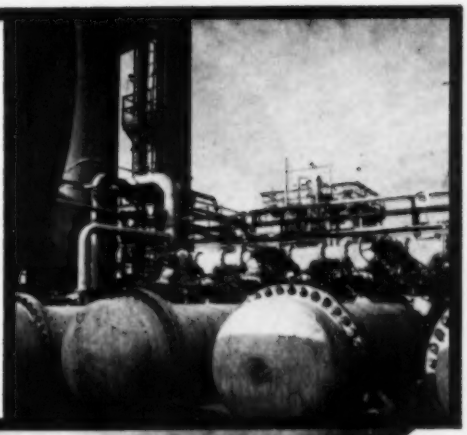
The Lummus Company has been authorized to offer Shell Development Company's new hydrodesulfurization process and is currently building a hydrodesulfurization unit for Shell at Stanlow, England.

### Mathieson Names Division Head

Thomas C. Keeling, Jr., has been appointed president of Mathieson Hydrocarbon Chemicals division of Mathieson Chemical Corporation. He formerly was assistant vice president and sales man-

# Looking for an Economical Bolting Combination?

## Here it is



If you're looking for dependable fasteners for high-temperature, high-pressure bolting jobs, you'll surely like the combination of the Bethlehem Continuous-Thread Stud and two Bethlehem Quenched Nuts. This effective trio proves its economy in two ways: (1) It resists premature fatigue failure induced by fluctuating temperatures and pressures, and (2) It helps to minimize costly down-time.

**Bethlehem Continuous-Thread Stud.** Ideal for difficult bolting applications because it minimizes stress-concentrations. The stud has no point of thread-runout, therefore stresses cannot strike at any one point to cause premature failure. Instead, they are effectively distributed along the full working length of the stud. The continuous-thread stud is made from carbon or alloy steels, and comes either plain or heat-treated. You can count on it for long service.

**Bethlehem Quenched Nut.** Made from .40 to .50 carbon steel by forging and extruding hot steel in a forming die, then quenching and tempering. This process enables the nut to develop the full strength of any stud or bolt.

Both the Bethlehem Continuous-Thread Stud and Quenched Nut are made in a full range of sizes. They make a long-lasting bolting team. If you would like additional information about this bolting combination, the nearest Bethlehem office is at your service.

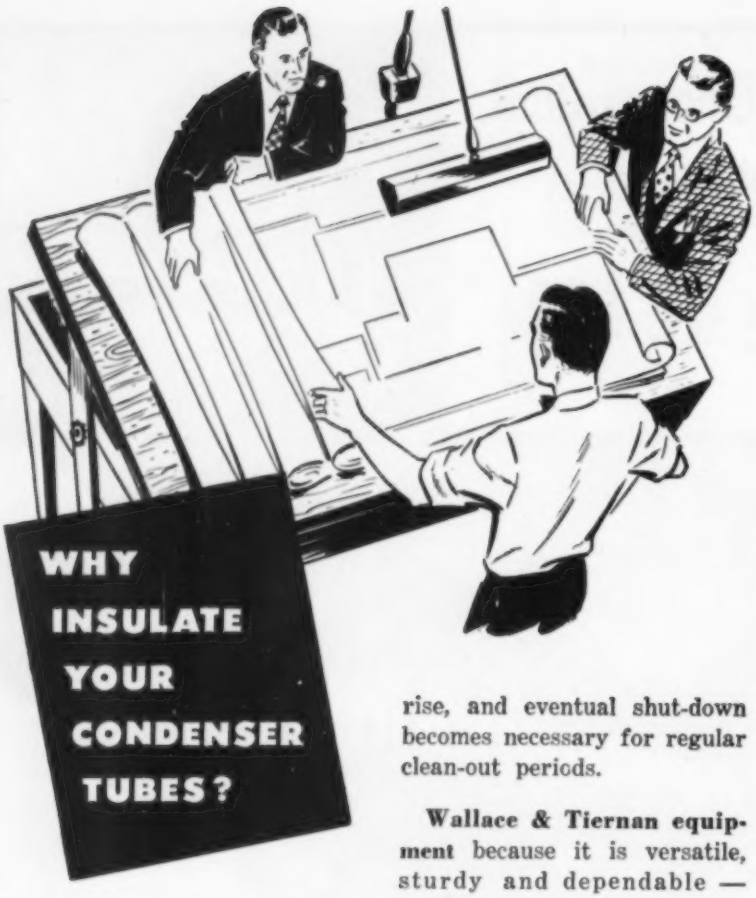
***Made at Lebanon Plant... Key to Quality***

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

*Bethlehem supplies every type of Fastener*




You may be doing just that if your plans don't include CHLORINATION EQUIPMENT for slime control by WALLACE & TIERNAN.

**Chlorination equipment** because it controls slime that *grows* on the walls of condenser tubes not protected against it. Enough of the growth eventually seriously reduces heat transfer efficiency — actually *insulates* your steam from the cooling water. Back pressures go up, production drops, operating and maintenance costs rise, and eventual shut-down becomes necessary for regular clean-out periods.

**Wallace & Tiernan equipment** because it is versatile, sturdy and dependable — proven by thousands of successful installations, vouched for by satisfied users everywhere-and because there's a Wallace & Tiernan chlorinator for every job. Write today for information on how Wallace & Tiernan chlorination may help you solve *your* slime problem.

**NO WATER IS SLIME-FREE**

regardless of the source. Chlorination helps reduce slime in process or cooling water.

CD-37

**WALLACE & TIERNAN**
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES



ager of the chemical division of Koppers Company, Inc., and served as director of the chemical division of National Production Authority.

## Lubrication Engineering Study Offered in MIT Summer Program

An opportunity to study applications of new techniques and methods in lubrication engineering will be offered engineers in industry during a two-week Special Summer Program from June 12 to 26 at the Massachusetts Institute of Technology.

The program, according to the director of the MIT Summer Session, is intended for engineers responsible for lubrication maintenance and scheduling in industrial plants and for chemists and others in the oil industry who wish to become better acquainted with the field of lubrication engineering.

Further information concerning the special summer course and application blanks may be obtained from the Director of the Summer Session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39.

## Lion Oil Presented Safety Awards For Accident Prevention in 1952

The National Safety Council has presented two Awards of Honor to Lion Oil Company for the accident prevention record set by its employes in 1952. The Award of Honor is the highest industrial recognition for safety achievement given by the Council.

The company as a whole, with more than 2600 employes, was given an award for "a remarkable reduction in the frequency and severity of accidents." Employes of the company's Manufacturing division, consisting of the El Dorado, Ark., refinery and the El Dorado chemical plant, won the other award "for working in excess of three million man hours without a disabling injury."

T. M. Martin, Lion president, gave entire credit to the employes and said that "our outstanding records were achieved by individuals working together."

## Kellogg Announces Formation Of Chemical Processes Division

A special division devoted exclusively to the process design of plants for the petrochemical and chemical fields has been established by The M. W. Kellogg Company. In addition to the new division, Kellogg will further increase its activities in the petrochemical and chemical fields by additional emphasis in its Research and Development department and by continuing to acquire rights for new chemical process which supplement designs already developed by the company.

## Cities Service Announces Clark and Hill Elected to Board

Glenn W. Clark, president of Cities Service Gas Company, and George H. Hill, Jr., vice president of Cities Service Petroleum, Inc., have been elected to the board of directors of the parent Cities Service Company.

Clark has been associated with Cities Service in various capacities since 1930. Following service as vice president and

*only the heater used in*

# ifp*

## PROVIDES ALL THESE

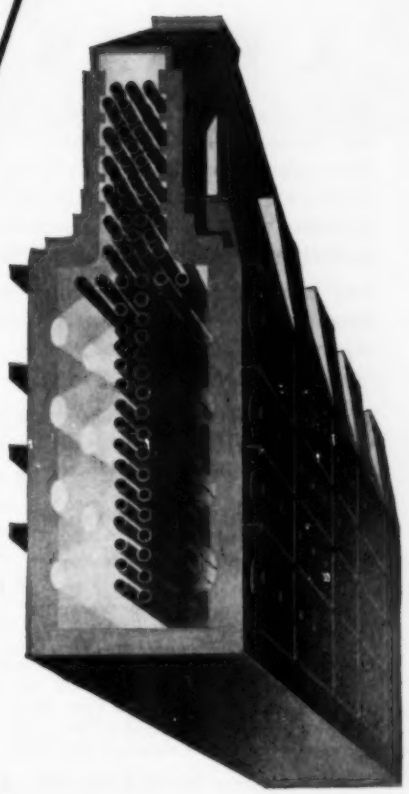
- Direct, controlled radiant heat along and around the horizontal heating tubes
- High, uniform rates of heat transfer
- Heat input to match any desired heating curve
- Low residence time at temperature, where desirable
- Complete combustion, with little or no excess air
- Positive heat rate control at either high or low temperature operation

Petroleum and petrochemical heaters, featured by performance as exemplified above, form a part of the over-all Selas activities in the *Improved Fluid Processing* of air, gas and liquids. Removal of water, oil and vapors from instrument or process air and the phase separation of liquids are functions of other Selas refinery apparatus.

IFP* is not a piece of equipment... nor simply a method. It is a combination of modern techniques and equipment, fitted to specific needs by engineers with refinery operation backgrounds.

A letter will bring you full details.

***Improved Fluid Processing**



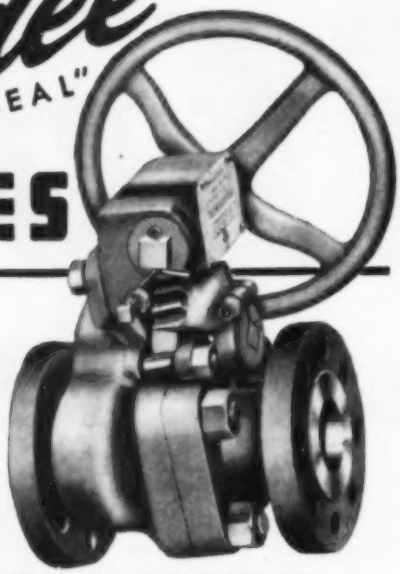
**SELAS**

**CORPORATION OF AMERICA**

**PHILADELPHIA 34, PENNSYLVANIA**

***Development • Design • Manufacture***

# APPROVED Okadee "PERFECT SEAL" VALVES



## for Bubble-tight Primary Shut-off in L P GAS LINES

**Underwriters' Laboratories, major LP gas producers*, and Liquified Petroleum Gas Commissions of several States* approve Okadee Valves for primary shut-off in LP gas lines. In addition, Okadee Valves are used in virtually all types of gas and liquid lines at pressures to 600 p.s.i. and temperatures to 800°F.—wherever a perfect seal, low maintenance and long life are necessary.**

**Get complete data, including material specifications, on Okadee Valves — and newest Underwriters' Laboratories test report—without obligation, today.**

**Names on request.*

- **A. S. A. Standard dimensions**
- **Sizes from ½" to 6"**
- **Single- and double-seated disc valves**
- **Hard-faced valves and seats . . . perfect metal-to-metal seal**
- **Self-cleaning, self-compensating valve discs**
- **Lever, rack-and-lever, or worm-gear operation**
- **Non-lubricated**
- **No wedge action**
- **Valves and seats wear in instead of "wearing out"**
- **All parts quickly replaceable in the field**
- **Inside and outside stem packing . . . double assurance against stem leaks**

**Underwriters' Laboratories Reexamination Service Guide No. 141 A3.1.22, File MH5163. SL Screwed Type Series and Series 15 and 30 Flanged Type Okadee Valves are suitable as a positive shut-off in LP gas pipelines and other LP gas applications for a working pressure of 250 p.s.i.**

**Write for Bulletin No. 51FL**

OKa. **Okadee COMPANY**
332 South Michigan Avenue • Chicago 4, Illinois


## [ What's Happening ]

general counsel for Cities Service Gas Company, he was named president in 1952.

Hill, associated with Cities Service since 1945, is a director in a number of its subsidiaries. During World War II, he served in various governmental capacities in Washington and was executive vice president and general counsel of Defense Supplies Corporation.

### Indiana Standard Names Larson To New Mandan Refinery Post

M. D. Larson has been named superintendent of the industrial relations division at the new Standard Oil Company (Indiana) refinery at Mandan, N. D. Since 1950 he has been assistant superintendent of the industrial relations division at Standard's Sugar Creek, Mo., refinery near Kansas City, Mo.

Larson joined the company as assistant personnel and safety supervisor for the Des Moines, Iowa, sales field in 1946, was transferred to Sugar Creek a year and one-half later to establish the refinery's supervisory training program.

## CONSTRUCTION

Further items on page 105

### Mississippi Chemical Hiking Capacity of Yazoo City Plant

Capacity of Mississippi Chemical Corporation's Yazoo City, Miss., ammonia plant is being increased from 120 to 180 tons per day. The new construction will entail an investment in excess of $2 million. Work on the project is expected to be completed late in 1953. The Girdler Corporation is the prime contractor.

### Braun Awarded Contract for Sinclair Catalytic Reformer

A 16,000-barrel-a-day catalytic reforming unit will be built by Sinclair Refining Company at its Marcus Hook, Pa., refinery. The unit will produce the higher octane gasolines to be required by future high compression engines.

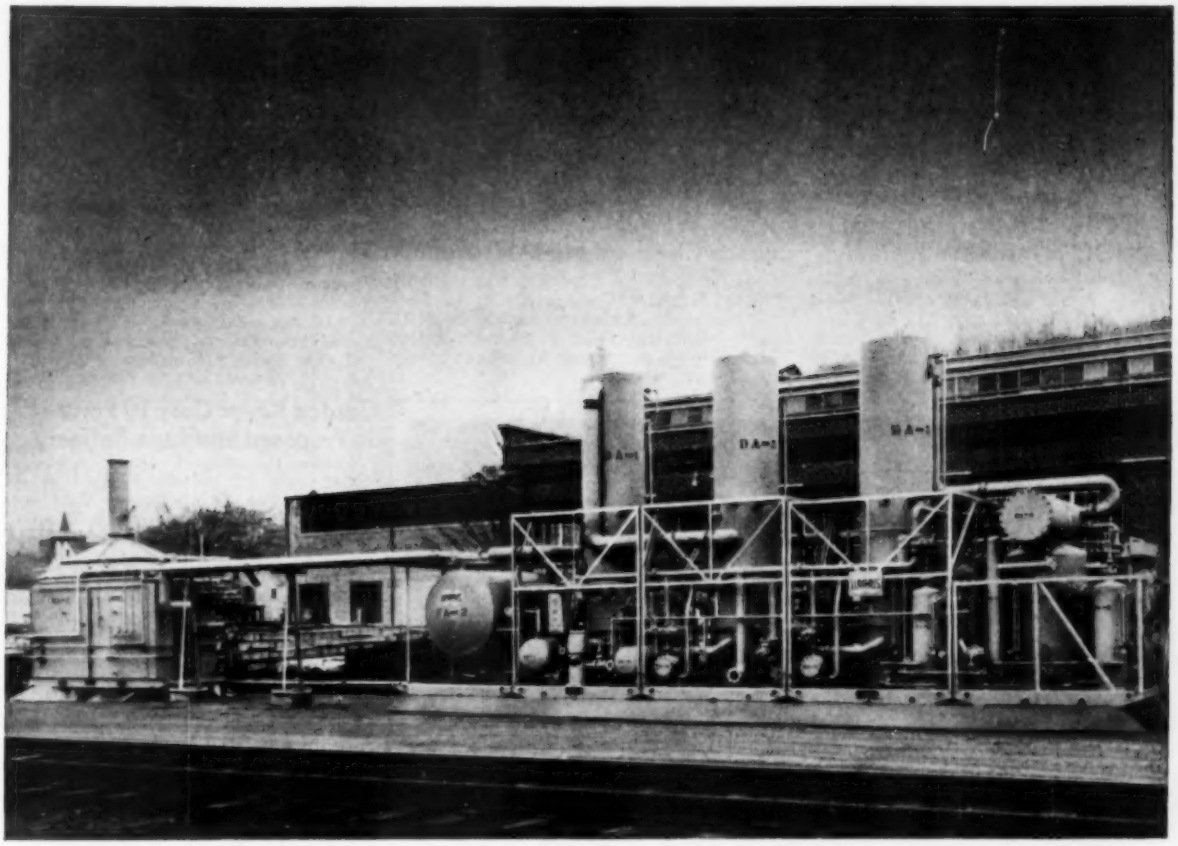
The new reformer will be part of a $14 million construction project designed to increase the company's production of strategically important petrochemicals. Construction contract for the catalytic reformer has been awarded to C. F. Braun & Company. Completion has been set for the summer of 1954.

The unit will employ a new processing method and platinum catalyst recently developed by Sinclair Research Laboratories, Inc., and Baker & Company, Inc., platinum specialists.

### Suntide Refining's New Plant Scheduled to Be Completed Soon

The first steel tower has been hoisted into place at the new Corpus Christi, Texas, refinery of Suntide Refining Company, now under construction. The tower is part of a crude topping unit expected to be on stream by next August. It will be followed by a new catalytic cracking unit in September.

The 33,000-barrel-a-day plant is lo-



# *Ever See a Traveling Refinery?*

Here's one—probably the world's first *portable* topping unit, designed and built by Lummus to meet the special needs of a customer.

Skid-mounted, the unit can be broken down into five sections, transported on only three flatcars, and assembled quickly at destination. Towers are designed to permit placing in a horizontal position on flatcars.

This is a complete petroleum refinery, designed to charge 1,000 barrels per day of crude . . . producing motor fuel, jet fuel, fuel oil and a bottoms product suitable for road oil. The unit is compactly self-sufficient—consisting of a direct-fired oil heater, three towers, heat exchangers and pumps and instruments.

Perhaps there's little resemblance between this unit and some of its Lummus-designed "big brothers", with charge capacities sixty times as great. But what this job does demonstrate is the engineering versatility and fabrication ability that enables Lummus Heat Exchanger Division to handle just about any assignment—the unusual as well as the usual.

These are good reasons why *you* should call on Lummus for your next project involving the design, engineering and fabrication of heat transfer equipment.

**THE LUMMUS COMPANY**

**HEAT EXCHANGER DIVISION • 385 MADISON AVENUE, NEW YORK 17, N. Y.**

Albany • Atlanta • Boston • Chicago • Cincinnati • Dallas • Denver • Detroit • East Chicago • Houston • Kalamazoo • Kansas City • Minneapolis • Nashville • Newton (Ia.) • Omaha • Pittsburgh • Rochester • San Francisco • Toledo • Tucson • Tulsa • Wayne (Phila.) • Antwerp • Athens • Buenos Aires • Caracas • Frankfurt • Lima • London • Mexico City • Paris • Rome • San Juan • Toronto

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

cated on a 134-acre site. It will be a complete refinery, producing jet fuel, aviation gasoline, motor fuels, diesel oil and Bunker "C" fuel oil. Lummus Company holds the contract for construction of the plant.

## 40,000 Tons of Materials Sent To AIOC's New Aden Refinery

Since work began in October last year at Aden, on the Red Sea, more than 40,000 tons of materials have been shipped to the site of Anglo-Iranian Oil Company's new 100,000 barrel-a-day refinery. About 85 percent of the materials are from the United Kingdom.

Work on the oil harbor adjoining the refinery site will be speeded when six barges, for moving heavy materials, are put into service. Two dredgers, a pump-ashore plant and several small craft are now being used in the port construction work.

## Foster Wheeler to Construct Grace Chemical Memphis Plant

Grace Chemical Company has named Foster Wheeler Corporation to handle engineering and construction of its $19 million nitrogen plant to be built near Memphis. Construction is expected to begin right away.

## Pritchard Given Contract for Signal Natural Gasoline Plant

Signal Oil and Gas Company has awarded to J. F. Pritchard and Company a contract for the engineering, design and construction of its new natural gasoline plant to be built at Tioga, N. Dak. Actual construction is expected to start in early summer.

The plant will be designed to treat eventually 65 Mmcf. of gas per day from the Beaver Lodge-Tioga fields. Until crude oil pipe line facilities are installed, however, only about one-third of this volume of gas will be available. Because of this, some equipment will not be installed immediately. The entire project will cost about $15 million.

## Cosden Keeps Only 10 Percent In Proposed San Juan Refinery

Cosden Petroleum Corporation has retained only 10 percent interest in its proposed San Juan, Puerto Rico, refinery. Gulf Oil Corporation, Pontiac Refining Company and J. H. Whitney Company, financial house, control the remaining 90 percent.

Construction of the plant will start as soon as the group succeeds in getting contracts to supply the island's power plant fuel oil requirements. The new project will be known as Caribbean Refining Company.

If the group does not get the power plant contracts, "the whole plan might be thrown out the window," R. L. Tollett, president of Cosden, stated.

## Canadian Oil to Replace Units Destroyed by Fire at Montreal

New facilities will be built as soon as possible to replace the Canadian Oil Companies, Ltd., lubricating oil and grease manufacturing plant at Montreal which was destroyed by fire last month. Company officials have already started a survey to determine the size, type and layout of the new facilities. The plant which was destroyed was only 18 months old.

## General Petroleum Starts Work On New $35 Million Refinery

Construction of General Petroleum Corporation's $35 million refinery near Ferndale, Wash., on Puget Sound is scheduled to begin right away. To have a capacity of 35,000 barrels a day, the plant is to be constructed by Bechtel Corporation and is expected to be completed in late 1954.

## Sunray Oil Makes Changes in Gas-Gasoline Field Operations

The field operations of Sunray Oil Corporation's gas-gasoline division, formerly under supervision of the company's Manufacturing, Sales and Pipe Line department, has been transferred to Sunray's Exploitation department.

E. J. (Ernie) Mills who has been manager of the company's gas-gasoline division since November 1952, will continue to be in charge of these operations, now assigned to the exploitation department which combines all field operations including drilling and oil and gas production.

Mills joined the company in 1943 and

The New ALBINA
Circular!
MECHANICAL STIRRUP
Ideal for: The construction, painting and maintenance of pressure tanks, vessels, etc.
ALUMINUM DIAMOND PLATE DECK PLATFORM
Platform as shown may be used as a 6, 16, 22 or 28-ft. swing stage. Platform consists of two 6-ft. and one 16-ft. sections. Can be used as a swing stage, single stirrup or basket. Air or electric operated.
ALBINA MECHANICAL STIRRUPS are gaining in popularity by contractors across the nation. Workers like their safety features and convenience of rigging.
On Display
INTERNATIONAL PETROLEUM EXPOSITION
Tulsa, Okla.
May 14-23
Write for Complete Illustrated Catalog
ALBINA ENGINE & MACHINE WKS.
2100 N. Albina Ave. Portland, Oregon

# CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY MAY 1953

**NOTES ON**

## Ammonia

Of vital importance to the efficiency and low maintenance cost of any ammonia plant is the design of the reactor in which synthesis gas is converted to the end product.

* * *

*Close control of temperature is extremely important in the reactor. To attain a reaction rate high enough to produce an economic yield of ammonia, temperatures must closely approach a critical point. Should this point be exceeded, catalyst activity deteriorates rapidly and construction materials are subject to accelerated attack by corrosion.*

* * *

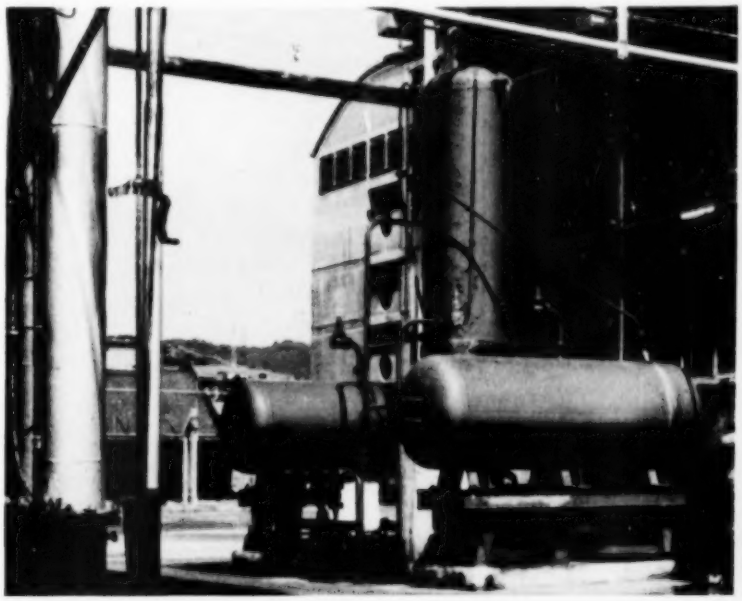
In the ideal ammonia converter, it is essential to remove excess heat as rapidly as possible from every point where exothermic reaction occurs. Since these points "move about" through changes in the conditions of operation and through aging of catalyst, the design of an economical converter that completely solves the problem of excess heat removal is a difficult engineering feat.

* * *

*The Kellogg reactor, which employs layers of catalyst with an efficient means of cooling the gases in between, closely approaches the ideal point-by-point temperature control.*

* * *

In addition to a 150 ton-per-day plant now going up on the West Coast, Kellogg has designed several others employing this type of reactor. Three large ones were built virtually simultaneously during World War II. Since they have been in operation they have continued to maintain the highest efficiency levels in the industry.



## Lower Initial Investment, Decreased Operating Cost with New Urea Process

A new, low-cost method of producing synthetic urea of exceptional purity from ammonia and carbon dioxide is now available in the United States through Kellogg. Known as the Montecatini Urea Process—after the well-known Italian firm which developed it—the method reflects more than 30 years of experience in nitrogen chemistry.

One of the important features of the Montecatini process is the reduction in operating cost due to the virtual elimination of the corrosion problems generally associated with urea synthesis. This is accomplished not only through judicious materials selection but also through the use of relatively mild operating conditions in the reaction zone in comparison with other urea processes. Furthermore, high concentration of ammonia also tends to curb corrosion.

To reduce initial investment, as well as operating costs, the process employs a partial recycle of ammonia and ammonium carbamate in liquid form in order to keep to a minimum the need for costly compressors. The lower temperatures employed eliminate the necessity for employing expensive alloy equipment in many parts of the plant.

While a total recycle plant that gives 100% yields has been piloted, the present commercially operating process makes it possible to obtain 70 and 80 wt. % conversion of $NH_3$ and $CO_2$ respectively. Considering the fact that urea production is often in connection with the preparation of fertilizer products, the existence of excess ammonia in the tail gas provides a ready source of $NH_3$ for additional production of the standard sulfate and nitrate fertilizers.

In addition to these factors affecting the costs of plant and operation, it is also of interest that the process produces resin-grade urea under all conditions without the additional expense of a special purification step to remove entrained impurities. The product from the Montecatini process meets the following specifications:

| | |
|---|---|
| Nitrogen | 46.3 wt. % |
| Water Content | 0.5 wt. % |
| Free $NH_3$ | 0.02 wt. % |
| Ash | 0.003 wt. % |
| Biuret | 0.01 wt. % |
| Aqueous solution of 5% urea | clear and colorless |

This final specification is a difficult one to meet and is particularly important for plastics manufacture. The low biuret content is also of importance in this application.

This process employs no lead-lined equipment, eliminating any possibility of lead toxicity when urea is used as cattle feed supplement.

(SEE REVERSE SIDE)

CONTINUED FROM PRECEDING PAGE

## More than 20 Major Chemical Processing Steps Involved in Project

**The South African project** to obtain gasoline, diesel fuel and chemicals from indigenous coal deposits is now well underway. The huge $50 million plant, for which Kellogg is project manager, comprises a multitude of different units. The overall program includes projects from the opening of a virgin coal mine to the final production of fuels and purification of chemicals. Progress photos shown here include just four of the major chemical processing projects included in this most complex chemical engineering-contracting task for South African Coal, Oil and Gas Corporation (SASOL).

Photo No. 1 shows the unit which will receive the gas stream from the coal gasification plant to produce synthesis gas. This is then fed to Kellogg's unique Synthol process (Photo No. 2) where the actual synthesizing step is performed. Progress on the fixed bed catalytic operation is shown in Photo No. 3. When completed, the foundations shown in Photo No. 4 will support the oil recovery system.

Among the chemicals which will be produced as dictated by market conditions are ethanol, propanol, butanol, acetone, methyl ethyl ketone, benzol, toluol, phenol, ammonium sulfate, light and heavy creosotes and several waxes and tars.

* * *

***For further information, technical data, etc., relating to chemical or petrochemical processing, write***

**CHEMICAL PROCESS DIVISION**
**THE M. W. KELLOGG COMPANY**
225 Broadway, New York 7, N. Y.
Also Jersey City,
Los Angeles, Tulsa, Houston, Toronto, London and Paris
KELLOGG PULLMAN

## RESA Branch Is Installed at Kellogg

Dr. Donald B. Prentice, National Director of the Scientific Research Society of America (RESA), presents official charter to Joseph F. Skelly, first president of the new Kellogg RESA branch. Warren L. Smith, president of Kellogg standing at left, was one of prime movers for formation of a RESA unit. The Company mustered 58 charter members at the recent investment ceremony, expects the branch's eventual membership to number in the hundreds.

KELLOGG
ETHYLENE PROPYLENE BUTYLENE
KELLOGG
ACETYLENE
KELLOGG
TOULENE BENZENE XYLENE
KELLOGG
ETHANOL PROPANOL BUTANOL ISO OCTYL ALCOHOL
KELLOGG
AMMONIA UREA
KELLOGG
CARBON MONOXIDE HYDROGEN
KELLOGG
GLYCERIDES
KELLOGG

was formerly superintendent of the company's Benton, La., gasoline plant. From 1952 until his assignment to the general offices in Tulsa last November, he was the district superintendent in charge of the company's West Texas gas-gasoline production, including the Snyder gasoline plant in Scurry County, Texas, operated by Sunray.

## Humble Promotes Glenn Wilson In Baytown Technical Service

Promotion of Glenn W. Wilson to section head in the technical service of its Baytown, Texas, refinery has been announced by Humble Oil & Refining Company. The new section which he will head will handle technical service activities associated with rerun distillation and light oil treating.

Wilson

Wilson went to Baytown in 1935, working at first in the field of thermal cracking. For the past two years he has been a specialist in design and operation of fractionating towers.

## California Research Engineer Receives ASLE Junior Award

Adrian C. West, research engineer with California Research Corporation, has been named 1953 recipient of the Walter D. Hodson Junior Award of the American Society of Lubricating Engineers.

West, a graduate of San Jose State College was given recognition for his paper "Friction and Boundary Lubrication," presented to the ASLE northern California section last year. He has been with Cal Research, a Standard Oil Company of California subsidiary, since 1946.

## *Chemicals Wanted*

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Molybdenum carbonyl
1,1,3-Trichloroacetone
2,3,5-Trinitrotoluene
Ethylvinyl ketone
Pentaphenylethane
3,3-Dichloropropene-1
2-Cyanobutadiene-1,3
Trinaphthylmethane
3,4,5-Trichlorobenzaldehyde
Thiobenzoic acid
Isophthalaldehyde
2,6-Dimethylheptanetriol-2,4,6
Methyl α benzylacrylate
para-Hydroxystyrene
Dibromofluoromethane
1,8-Dimethylnaphthalene
3,5-Dinitrobenzaldehyde
1,7-Dichloronaphthalene

## Bowen Named Superintendent Of Sun Oil's Sarnia Refinery

Appointment of Frank W. Bowen as superintendent of Sun Oil Company's refinery now under construction at Sarnia, Ontario, Canada, has been announced. Bowen, formerly chief chemical engineer at Sun's Toledo, Ohio, refinery, will supervise plant operations under the direction of Gordon R. Henderson, recently appointed refinery manager.

Bowen joined Sun's Marcus Hook, Pa., refinery. After serving in the Development division at Marcus Hook for two years, he was transferred to the company's general office in Philadelphia and promoted to process engineer. He has been chief chemical engineer at the Toledo refinery since 1944, the announcement disclosed.

## AIChE Makes Plans to Study Nuclear Processes Next Year

The chemical engineering aspects of nuclear processes will be explored in a week-long international meeting being planned by the American Institute of Chemical Engineers for June 1954. Present plans schedule the meeting for the week of June 20-25, 1954 at the University of Michigan. Experts from all over the world will be invited to participate.

In charge of the technical program is Professor D. L. Katz, head of Michi-


# Can you afford to be without corrosion-resistant thermometers?

**Production errors caused by thermometer failures can be mighty costly.**

**The corrosion-resistant, pressure-tight construction of Rochester dial thermometers protects you from this sort of expensive trouble. And it practically doubles the life of the thermometer under severe operating conditions.**

*An exclusive stainless steel welding process bonds the case, stem and nut into a single corrosion-resistant unit.*

**RECALIBRATE ON THE JOB**

**Rochester dial thermometers are built to stay accurate under rough treatment. But if an unusually hard blow knocks the pointer out of adjustment, you can recalibrate it quickly and easily by turning a single screw.**

**You can order money-saving Rochester thermometers from one of our specialized instrument representatives, listed in Sweet's Catalog or the yellow pages of your telephone directory. Or just mail the handy coupon for full details.**

**MILLIONS of Rochester dial thermometers are now delivering dependable service**

*Rochester*

**DIAL THERMOMETERS**
**GAUGES**
**AMMETERS**

**Rochester Manufacturing Co., Inc.**
**38 Rockwood Street, Rochester 10, N. Y.**

Send me complete information on Rochester corrosion-resistant dial thermometers.

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

CITY..... ZONE..... STATE.....

# *Brand New*

# TRI-ACT®
# CONTROLLER

*The newest Concept in Process Control gives you:*

1. Faster recovery on load changes
2. Start-up with no over-peaking
3. Benefits of automatic reset without its "evils"

THREE YEARS field experience proves new circuit principle not only sound but wanted more than ever. This unique force-balance controller capitalizes on faster speed of response of TRANSAIRE* measuring elements to give better control quality.

**Easy Alignment.** A fine thread gives a soft, vernier adjustment.

**Settings "stay put".** Permanent mechanical alignment. No one adjustment affects any other adjustment.

**Pneumatically Stable.** Practically insensitive to air supply variations. Gives wide range of settings in sensitivity (gain) and Pre-Act time (derivative) without upsetting stability.

**Excellent Temperature Compensation** — major construction refinements.

**Interchangeability of TRI-ACT and BI-ACT* Controllers.** Identical plug-in manifolds permit 10-second changeover with negligible process disturbance.

**Die-cast Aluminum** — light weight and corrosion resistant.

**Response Adjustment Dials Totally Enclosed** — protection against tampering and corrosion.

**Maintenance Simplified.** Any one section of the instrument can be removed for servicing without disturbance to the remaining sections.

**Buy one—try one on your toughest problem. There's no better way to prove the unprecedented performance of the TRI-ACT Controller.**

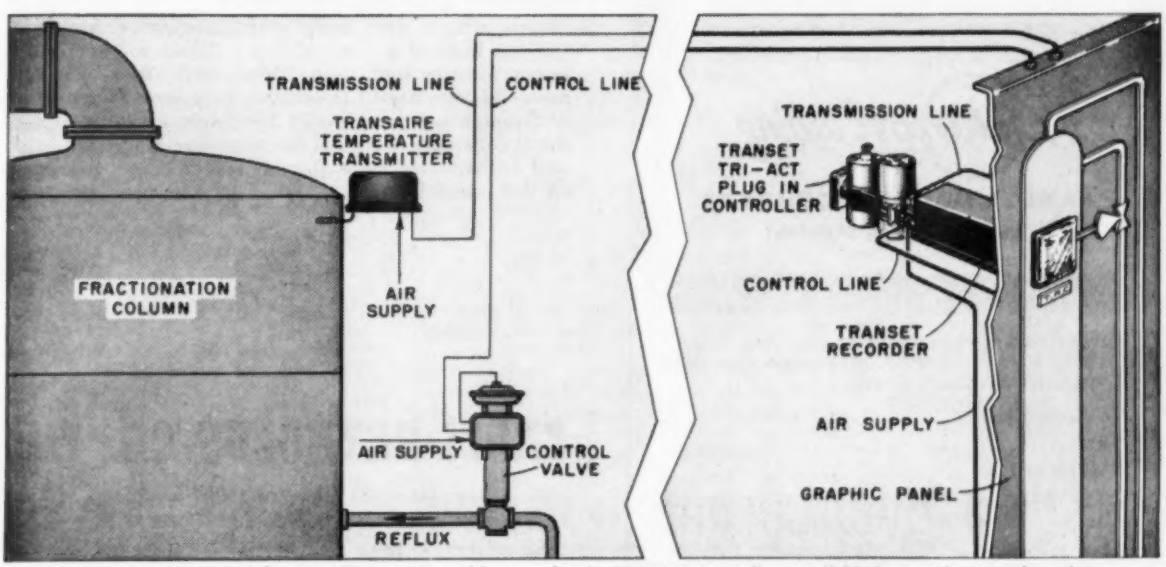
Call your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

*Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

*Trade-Mark

*Taylor Instruments*
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

THREE RESPONSE ADJUSTMENTS, calibrated in specific units of measurement, enclosed for protection against tampering and corrosion.
PLUGS IN to universal, self-sealing manifold for either panel or field mounting. Simplifies both piping and maintenance. Manifold accommodates both TRI-ACT and BI-ACT Controllers.
TWIN CYLINDER CONSTRUCTION permits quick, easy access to any one controller element for alignment or maintenance without disturbance to any other element.




*Typical application of the 3 part Transet Control System, showing TRI-ACT Controller manifolded to panel-mounted receiver.*

## DEKORON INSTRUMENT TUBING

Troubled by external corrosion, premature replacement or high installation costs of your instrument lines? Then send for our new bulletin:

"3 WAYS TO WHIP CORROSION AND HIGH TUBING INSTALLATION COSTS IN YOUR PLANT." It tells you all about Dekoron Instrument Tubing and Impervapak.

No matter what your corrosion problem, Dekoron Instrument Tubing or Dekoron Impervapak will provide the answer. Moisture can't penetrate it . . . corrosive industrial atmospheres can't damage it. In addition, Dekoron Instrument Tubing and Dekoron Impervapak will slash your tubing installation costs drastically.

So fill in the coupon below and get all the facts. See how Dekoron can whip your tubing corrosion problems.

A-7189

Dekoron® tubing

**SAMUEL MOORE & COMPANY**

**Dekoron Tubing Division**

Mantua, Ohio

Please rush my free copy of your new Bulletin L-6506 **"3 WAYS TO WHIP CORROSION AND HIGH TUBING INSTALLATION COSTS . . ."**

NAME .....

FIRM .....

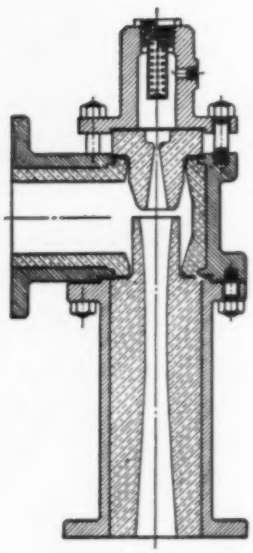
POSITION .....

STREET .....

CITY ..... STATE .....



# C-R EVACTORS



## MEET CORROSION PROBLEMS

**The chemical industries are employing more and more Croll-Reynolds Evactors in vacuum processes where corrosion resistance is a major consideration. These steam jet vacuum units provide pressures ranging from a few inches to a few microns. Croll-Reynolds is a pioneer in the use of new construction materials and our engineers are investigating corrosion problems continually.**

**Stainless steels, Monel metal, Beryllium copper, Ni-Resist, PMG metal, hard lead, special bronzes, Hastelloy, and Illium are but a few of the special metals which find their way into our equipment. Carbon is used extensively as a lining material, and many plastics including Teflon and other synthetic materials are used for making complete Evactors.**

**Consult our engineers for high vacuum equipment carefully designed for your specific conditions, and constructed of materials selected for your particular conditions.**

CROLL C R REYNOLDS

## CROLL-REYNOLDS CO., Inc.

**Main Office: 751 Central Avenue, Westfield, N. J.**

**New York Office: 17 John Street, New York 38, N. Y.**

**CHILL VACTORS • STEAM JET EVACTORS • CONDENSING EQUIPMENT**

gan's Chemical Engineering Department, who was also recently appointed head of the Nuclear Energy Committee of AIChE. The program is to begin with a day-long conference on the educational problems associated with training engineers in the nuclear field. A two-day program is planned on the design of nuclear power reactors; a full technical discussion is scheduled in fuel resources, fuel preparation, chemical processing of spent fuel, disposal of radioactive products, use of isotopes, safety and instrumentation and control; and a conference will be held on the social impact of the atomic age.

Dr. R. R. White, professor of chemical engineering at the University of Michigan, will be general chairman.

## API Gets Louis Stork as Head Of New Abstracting Section

Louis C. Stork has joined the staff of the American Petroleum Institute as supervisor of the new Abstracting Section now being organized. Since 1942 he has been associated with The Texas Company, resigning to accept the API position.

For the past seven years, Stork has been supervisor of the Beacon, N. Y., laboratories of The Texas Company. He is regarded by librarians and chemists as an able librarian and literature organizer.

## University of Oklahoma Lists Seven Available Fellowships

Seven fellowships are now available in the school of chemical engineering at the University of Oklahoma. They are: American Gas Association, Black, Sivalls & Bryson, Inc., Gulf Oil Corporation, Magnolia Petroleum Company, Maloney-Crawford Tank and Manufacturing Company, The Texas Company and The Dow Chemical Company.

Further details about the fellowships may be obtained by writing R. L. Huntington, chairman of the School of Chemical Engineering, University of Oklahoma, Norman, Okla.

## McKay Moves to Curb Work at Bureau's Demonstration Plant

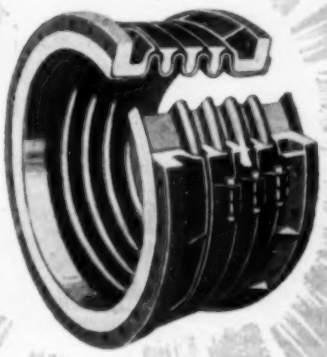
If Congress goes along with the wishes of Interior Secretary McKay, the Interior Department's Bureau of Mines will be forced to halt large-scale demonstration work on coal hydrogenation and gas synthesis processes for synthetic liquid fuels production.

McKay has asked the House Appropriations Committee to slash from the new budget the $2 million orginally slated (under the Truman budget) for the hydrogenation and synthesis plant at Louisiana, Mo. Such a cut would bring the total synthetic budget down to about $5.5 million for fiscal 1954.

The cutback in demonstration work was not unexpected in view of earlier indications that McKay would place considerable weight on a report from the National Petroleum Council recommending that expenditures be restricted to small pilot plants.

It has also been reported that the Bu-


Designed for
**DURABILITY**
as well as Flexibility



**DURABILITY is designed into the Badger Directed-Flexing, Self-Equalizing Joints:**

**1** each corrugation is designed with the proper depth for its diameter; each diameter is gauged to its proper traverse

**2** each corrugation—and it's the Badger ***all curve*** corrugation—is shaped to flex by Directed Flexing using matching shaped equalizing rings to guide and control the flexing movement. The corrugation wraps and unwraps itself, using the rings as the bearing surface, distributing the flexing stresses evenly over all areas of each of the all-curve corrugations.

**3** each corrugation is progressively controlled and limited to its proper flexing traverse

**4** the corrugations are formed from a single metal tube of suitable length by a special forming process which minimizes forming stresses in the metal

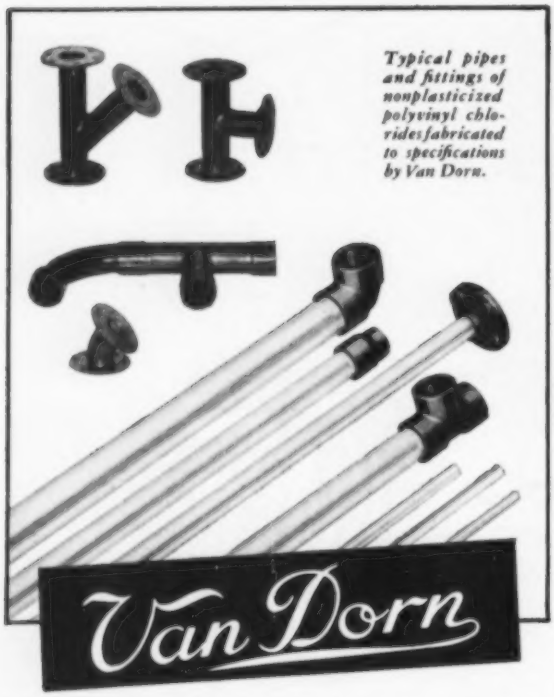
**5** every joint is scientifically heat-treated at each of several key steps in its manufacture

**The many thousands of Badger Directed-Flexing, Self-Equalizing Expansion Joints in service now for many years are in themselves testimonials as to their durability. They will serve you equally well. With a wide range of sizes in either flanged or welding end design, with a choice of several metals, with facilities for designing special joints, why not let our expansion joint specialists take care of your requirements?**

**BADGER MANUFACTURING COMPANY**

*Original and Sole Manufacturer of Badger Expansion Joints*

**230 BENT STREET • CAMBRIDGE • MASS.**



*Typical pipes and fittings of nonplasticized polyvinyl chlorides fabricated to specifications by Van Dorn.*

Van Dorn

**INDUSTRIAL PLASTICS OFFER YOU—**

✓ High Resistance to Acids & Alkalies

✓ Tensile Strength of Aluminum, with one-half its weight

✓ Readily Formed, Machined, Drawn Molded or Welded

**AVAILABLE FORMS**

SHEETS . . . . 1/32" through 1"
PIPE . . . . . 1/2" through 4" diameter (10 ft. lengths)
ROUND BARS . 1/4" through 2" diameter (10 ft. lengths)
WELDING ROD . 1/8" and 3/16" diameter

**TYPICAL APPLICATIONS**

Van Dorn fabricates its rigid nonplasticized polyvinyl chlorides into such products as: Ducts, Hoods, Chemical Tanks, Tank Liners, Plating Racks, Fume Stacks and Piping.

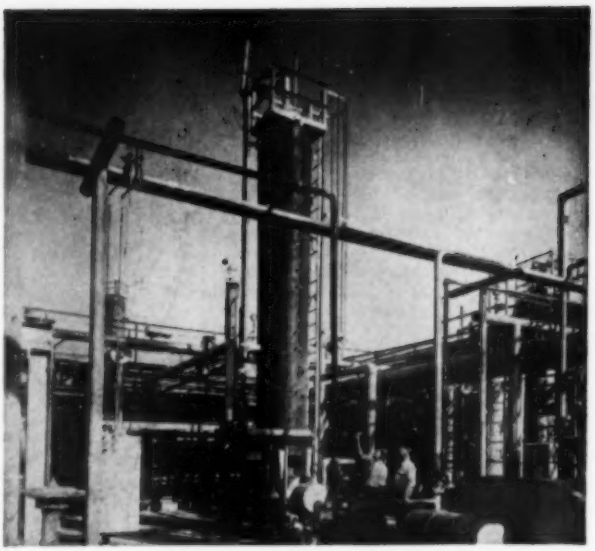
***WRITE FOR ILLUSTRATED BULLETIN AND SPECIFICATIONS***

*INDUSTRIAL PLASTICS DIVISION*

**THE VAN DORN IRON WORKS CO.**

2685 East 79th Street • Cleveland 4, Ohio





# "We gain 3 days production cleaning towers on-line"

**THAT'S THE REPORT** from a Texas plant superintendent. His 45 foot absorber tower produces 120,000 gals a day. Cleaning it used to take 4 days, with a production loss of $26,800.

Not any more. Now he just pumps a powerful Oakite detergent solution through the tower and circulates for about 20 hours. He not only gets 3 days more production—he saves $695 on cleaning costs, and gets these other advantages besides:

- **No cutting-in, no dismantling of equipment**
- **Thorough cleaning, even in hard-to-get-at spots for optimum metal inspection**
- **A minimum of abrading—critical dimensions remain unchanged**
- **Maintenance crew released for other work while solution circulates**

**TRY IT YOURSELF.** Ask your local Oakite Technical Service Representative. Or write Oakite Products, Inc., 44C Rector St., New York 6, N. Y.

See Us at
INTERNATIONAL PETROLEUM EXPOSITION
TULSA MAY 14-23
**Booths 22-23**

SPECIALIZED INDUSTRIAL CLEANING
**OAKITE**
MATERIALS • METHODS • SERVICE

*Technical Service Representatives Located in Principal Cities of United States and Canada*

reau of Mines has received preliminary offers from oil and chemical operators to take over the Missouri plant, although not necessarily to continue the same type of synthetics work.

In halting demonstration plant operations, the government has three alternatives: declare it surplus and sell it to private industry, lease it out to private operators or put it in mothballs for future reactivation.

## Justice Department Switches To "Cartel" Civil Complaint

The Justice Department will file a "civil complaint against major American and other oil companies for violations of the anti-trust laws through an international cartel," Attorney General Brownell has said. This, he stated, would be done prior to April 28—date on which subpoenas are returnable in the pending criminal grand jury proceedings.

In this suit to be filed in Washington, he said, DJ will seek production of the same documents in civil action as those called for on April 28 in grand jury proceedings. Companies will be asked, but will not be required to produce those papers, he said.

A DJ representative will appear before Federal District Judge James R. Kirkland April 28 "in connection with" grand jury proceedings, he continued. He stressed that Kirkland has sole authority over the grand jury and its disposition. While DJ would not divulge what it will state to Kirkland, it was considered reasonable that it would request dismissal of the jury. When postponing proceedings last January, Kirkland indicated that he favored a civil suit approach and would probably accede to such recommendations.

Another DJ official has said that the department has been holding discussions with company representatives but declined to reveal the exact topics or company attitudes. One company attorney, however, said the change came as a surprise. He declared that at no time was the question of consent decree in civil suit mentioned. He said that his company had not been asked to agree to civil order in lieu of criminal proceedings.

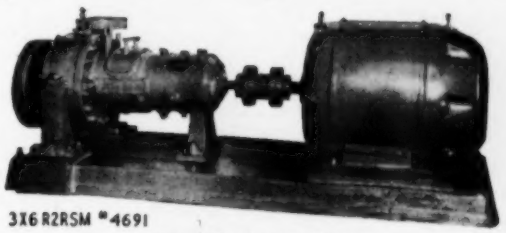
"To guard against a public disclosure of documents which might have an adverse effect upon the national security," a screening committee will scrutinize all documents, DJ said. Documents sought are those "in the United States relating principally to their operations abroad and the impact of those activities upon the foreign commerce of the United States."

"If necessary," DJ said, "subsequent application will be made to the court for production of documents located abroad."

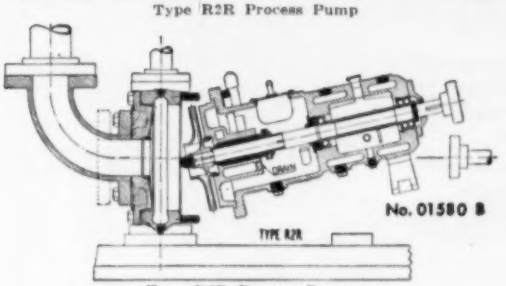
Of the Justice Department statement, George V. Holton, chairman of Socony-Vacuum Oil Company, Inc., said, "We have said several times that we saw no basis for the criminal proceedings against Socony-Vacuum, and we feel just as strongly that there is no basis for civil proceedings. Our only information about a proposed civil proceeding has been through the press. Under the circumstances, we think it inappropriate to comment further."


**DEAN BROTHERS PUMPS INC.**

Type R2R Centrifugal Process Pumps




Type R2R Process Pump




Type R2R Process Pump

**DISASSEMBLY:** The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

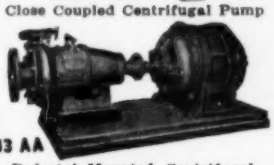
**OPERATING RANGE:** Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

*BUILDERS OF OUTSTANDING PUMPS SINCE 1869*

**CENTRIFUGAL and RECIPROCATING PUMPS**

Close Coupled Centrifugal Pump

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids




Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

Double Pedestal Bearing Centrifugal Pump

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

**DEAN BROTHERS PUMPS INC.**

INDIANAPOLIS IND.

323 W TENTH ST.

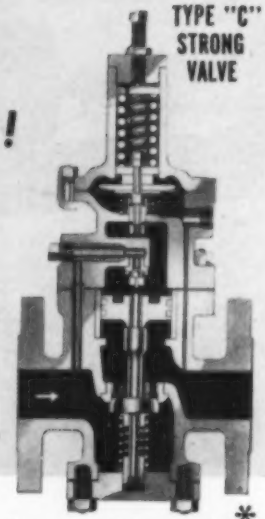
*Branch Offices:* NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

# GET THIS VALVE!

*Accurate pressure regulation!*

TYPE "C" STRONG VALVE



**FOR HEATING OR PROCESS JOBS:**

- ...with intermittent or fluctuating demand;
- ...requiring accurate control;
- ...where dependability is essential.

## For positive control, use this STRONG* single-seated, pilot-controlled valve!

Simple design, extra-heavy construction make STRONG's Type "C" regulating valve give trouble-free regulation. Semi-steel for pressures to 250 psi, 450° F.; cast steel to 600 psi, 750° F. With Anum-Metl† seat and disc, this valve automatically adjusts itself to control the flow of steam, air or gas required to maintain reduced pressure.

Write us about your pressure reducing problem or request our complete steam specialties Catalog 68-X.

**TYPE "O"**

Direct operated. Semi-steel construction suitable for initial pressures to 225 psi, 400° F. For steam, air, water or gas.

Features internal strainer, Anum-Metl† seat and disc. Direct operated, of extra heavy semi-steel, this valve is suitable for pressures to 225 psi, 400° F.

**TYPE "K"**

*Trade Mark Reg. U. S. Pat. Off.

**STRONG, CARLISLE & HAMMOND COMPANY**

1392 WEST 3rd Street
Cleveland 13, Ohio

† ANUM-METL Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES

No. 070 Small Trap

"SY" Strainer

800 Series Steel Trap

**STRONG**



# Refractory Problems

• Look to this symbol for an efficient, economical solution

**SCHAPANSKY AND KING**
**CONTRACTORS**

Specialists in the air placement of refractory materials and Gunite for the oil and chemical industries. Write today for full details.

**4110 Dennis • CE 8206 • Houston, Texas**

**PROTECT WORKERS AGAINST HARMFUL CONCENTRATIONS OF AROMATIC HYDROCARBONS— BENZENE, TOLUENE, XYLENE**

**...with the *NEW***

**M. S. A.**

**AROMATIC HYDROCARBON DETECTOR**

Workers are better protected against harmful concentrations of aromatics when this accurate, compact instrument is on the job. Concentrations are easily and quickly determined on the cylindrical scale which is separately graded for benzene, toluene and xylene. The length of stain, which increases with increasing concentrations permits testing crews to improve ventilation or alert workers when "safe limits" are exceeded.

The instrument is fast and simple in operation, and requires no special training to use. For complete details, write now for Bulletin No. DD-1.

MSA
SAFETY EQUIPMENT HEADQUARTERS

**MINE SAFETY APPLIANCES CO.**
**Braddock, Thomas & Meade Sts.**
**Pittsburgh 8, Pa.**
*At Your Service: 76 Branch Offices in the United States*

## INSURANCE Rate Cut Believed Not Unlikely

• CONTINUED FROM PAGE 221

minimum opposition in the Senate by reason of a compromise effected in the House Committee which answered a major criticism of many Senators.

This compromise maintains the right of appeal to the courts in compensation cases. The bill as reported out of committee provided that the Industrial Accident Board would be abolished and its three-man membership transferred to a Workmen's Compensation Board. Assisting the new board would be traveling commissioners empowered to hold preliminary hearings in the locale of accident cases. In the event no agreement could be reached, the case would go before the board as a whole and thence on appeal to the district and appellate courts.

A major victory for employers favoring the bill was retention in the committee of a sharp limitation on attorneys' fees. Now allowed 33⅓ percent of court awards plus 10 and 15 percent of accident board grants, attorneys would be limited to $2000 by the new law.

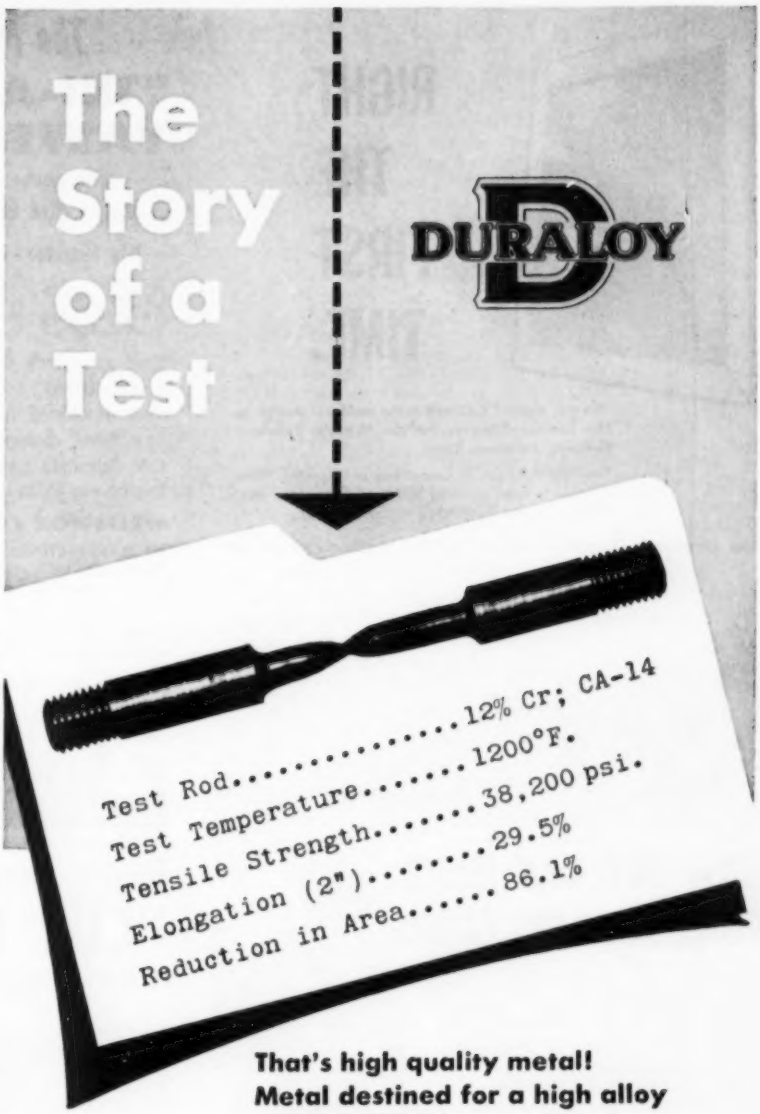
Other major points in the bill are (1) removal of employers' liability for employes' accidents in company vehicles when the employes are engaged in personal pursuits; (2) provision for self-insurance by a company; (3) an increase in maximum weekly benefits from $25 to $30 and an increase in the minimum from $9 to $12.

Meanwhile, The American Petroleum Institute announced that the industry's safety record in 1952 was the best in its history. The frequency rate of injuries for the industry as a whole declined to 9.67 per 1 million man-hours worked, marking the first time this index has dropped below 10. The previous all-time low for the frequency rate was in 1950, when the index was 10.08 per 1 million man-hours worked.

The severity rate, which is the number of shift-days lost per injury, dropped to 1.04 per 1000 man-hours worked in 1952.

The ratio of days lost to injuries in 1952, including fatalities, was an average of 107 days per injury. The 1951 average was 123 days per injury. Excluding fatalities, this average was 40 days per injury in 1952, compared with 39 days per injury in 1951.

The survey for 1952 was based on the collective experience of almost 300 oil companies and their subsidiaries, employing 516,180 persons and involving a total exposure of more than 1 billion man-hours.


**That's high quality metal! Metal destined for a high alloy casting which has to meet some pretty rigid specifications!**

The story we want to tell here is about our Testing Facilities. We have right in our foundry every conceivable testing facility needed when checking static or centrifugal high alloy castings for industry. Where required, we make complete chemical, metallurgical, and mechanical checks and tests. And have both a 400,000 volt X-ray unit and gamma-ray unit, for checking the final casting for hidden flaws.

As we see it, the only way to assure customers of high quality castings is to have and use all necessary facilities for testing and checking the heat, pour and finished casting.

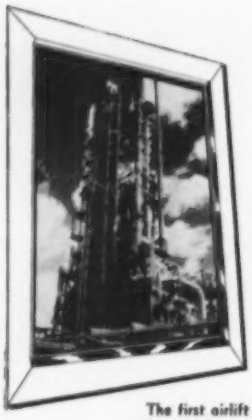
THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.

Detroit Office: 23906 Woodward Avenue • Pleasant Ridge, Mich.

Atlanta: J. M. TULL Metal & Supply Co. Chicago: F. O. NELSON 332 S. Michigan Avenue San Francisco: JOHN D. FENSTERMACHER 1241 Taylor Street

METAL GOODS CORP. Dallas • Denver • Houston • Kansas City • New Orleans • St. Louis • Tulsa



# RIGHT THE FIRST TIME.

The first airlift T.C.C. unit in the world was erected by The Lummus Company for the Magnolia Petroleum Company, Beaumont, Texas.

The John Dollinger, Jr. Corporation of Beaumont, Texas is proud to have furnished 350 tons of structural steel framing for this outstanding engineering feat.

FOR OVER 50 YEARS, LEADERS IN THE PETRO-CHEMICAL INDUSTRY HAVE LOOKED TO JOHN DOLLINGER, JR., INC. FOR QUALITY STEEL FABRICATION AND DEPENDABLE DELIVERY.

DOLLINGER AROUND THE WORLD.

For inquiries regarding fabricated structural steel and plate steel, write to John Dollinger, Jr., Inc., Beaumont, Texas.

*The New*

# "TRI-ALLOY" VALVE DISC

*can reduce your valve disc breakage!*

It's harder—tougher

## 82% STRONGER

than any stock disc we've previously offered. Tri-Alloy is precision machined from an entirely new 4-6% chrome alloy—a disc that definitely gives longer hours, less breakage, lower cost!

**WRITE FOR FULL DETAILS!**

**WE MANUFACTURE:** *Valve Discs*—Bakelite, alloy steels, stainless. *Valve Springs*—stainless, oil-tempered wire. *Valve Strips*—spring steel, stainless.

**WE DISTRIBUTE:** Hastings Aero and B-G low-fire-hazard type Spark Plugs.

*"Your Replacements Specialists"*

# TRI-STATE

MANUFACTURING & ENGINEERING CO., INC.
2041 E. 46th St. · INDIANAPOLIS 5, IND.

# HOW YOU CAN MAKE PUMP REPAIRS EASIER

Worn seats and valve discs, broken springs and stems are eliminated with Sims Pump Valves. Sims valves cure frequent pump repair headaches with exclusive design features. They're **guaranteed** to give you better pump performance.

You get longer service from seats and discs because of rotating disc that changes to a new seating-surface every time it opens. Valves can't hammer up and down.

Inclined rib seat and shock-absorber stem heads combine to permit increased speed without valve-knock. Capacity can be increased 40% and more.

Low resistance through seat reduces turbulence — gives protection against vapor binding.

Long guide gives even lift — reduces wear. Spring is protected against jamming.

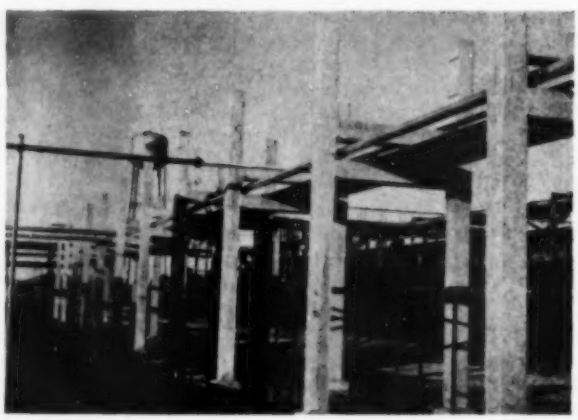
**Write for new catalog showing how Sims valves fit your pump and give better pump performance.**

SIMS PUMP VALVE CO., INC.

1314 PARK AVE., HOBOKEN, N. J. • M & M BLDG., HOUSTON, TEXAS

# Pipe Stanchion COSTS . . . "CUT TO THE BONE!"

PRE-CAST CONCRETE PIPE STANCHIONS—A NEW, PRACTICAL IDEA IN REFINERY CONSTRUCTION!



- **NO MAINTENANCE . . . ever!**
- **Low initial cost!** • **Insurance rates reduced!**
- **Adaptable to a variety of requirements!**
- **Designed for future expansion!**

One responsibility—engineered, manufactured and erected by the experienced RACKLE organization. Write for descriptive literature.

## The George Rackle & Sons Company

Manufacturers of structural concrete products since 1870

P. O. Box 15008, Houston 20, Texas, Phone ORchard-1736

# [ WHO'S MEETING ]

## API

Refiners' concern with water pollution was reflected in the papers presented at the 18th mid-year meeting of the American Petroleum Institute's Division of Refining, New York, May 11-14. In the session on analytic research, C. E. Headington, The Atlantic Refining Company, presented the work of the subcommittee on refinery effluent-water analytic methods, explaining the methods devised for finding as little as a few parts of oil in a billion parts of water.

### Newest Method for Refinery Effluent

A new method for determining how much oily material is suspended or dissolved in refinery waste waters was described by W. S. Levine, G. S. Mapes, and M. J. Roddy, Socony-Vacuum Laboratories. By the method, characterized as both rapid and accurate, the oil in a sample of water is extracted with carbon tetrachloride and the extract is transferred to a pycnometer to be weighed. From the difference in weight between the solution of oil in the carbon tetrachloride and the equal volume of pure solvent, the oil content of the water sample can be calculated.

### Also Use Mass Spec

For determining volatile contaminants in water, F. W. Melpolder, C. W. Warfield, and C. E. Headington, Atlantic Refining, presented a method for identifying as little as one part of gasoline, kerosine, or furnace oil in a billion parts of water. Furthermore, the method can tell whether oil is a petroleum product or from some other industry.

### Oxygen at Low Concentrations

As the result of the cooperative efforts of several petroleum laboratories, oxygen can now be accurately and precisely analyzed in concentrations down to as low as lpp parts per million, explained W. H. Jones, Esso Laboratories.

Although reasonably accurate methods have been available for determining oxygen in concentrations of 1 percent or higher, heretofore the analysis in the low and very low range has not been possible with any degree of accuracy.

### Pumpability of Fuel Oils

The shortcomings of pour point as a measure of pumpability were pointed out by F. Gill and R. J. Russell, Anglo-Iranian Oil Company; and the yield value of the oil was advocated as a more significant property which, together with rate of shear-stress data, can be related to the characteristics of an installation to predict the joint oil-installation behavior.

The authors indicated from their experience some consequential problems of pumpability and anomalous viscosity, together with some practical means of dealing with them on full scale.

### Eliminates Stopcock Contaminants

In LFTD analyses, contaminating stopcock grease can be avoided by use of metal valves for stopcocks. Hydrocarbons tend to dissolve in the stopcock grease in the distillation system and then may re-appear as a contaminant in a later sample. To use the metal valves, a convenient method for connecting metal to glass was accomplished by using tetrafluoro ethylene packing glands. Other pertinent uses for these glands were discussed by R. A. Brown and D. J. Skahan, Atlantic Refining.

### Check on Additive Concentration

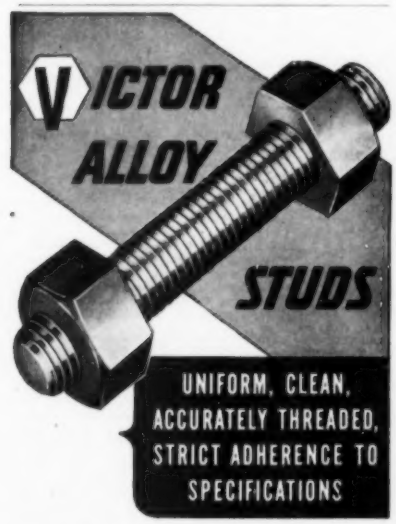
Attacking the problem of proper additive control in lubricating oils, E. N. Davis and R. A. Van Nostrand, Sinclair Research Laboratories, described a method which makes use of the X-ray spectrograph for the determination of barium, calcium, and zinc additives in oils at concentrations of 0.01 to 1.0 percent. Analysis for any one of these metal compounds can be completed in five to ten minutes with accuracies comparable to the best chemical methods. Conventional chemical methods, which are time-consuming and tedious, often delay the manufacturing process, since each batch of these oils must be carefully analyzed to assure proper additive concentration.

In X-ray spectrography a sample is bombarded with X-rays, causing the elements to emit their own characteristic X-rays. The radiation from the sample passes through a crystal, where it is separated into its various wavelength components. The intensity of these various components is measured with a Geiger tube, thus giving a measure of the concentration of these elements in the sample.

The specific additive, 4-methyl-2,6-ditert-butyphenol, has been analyzed in lube oils by an infrared absorption technique by Beacon Research Laboratories of The Texas Company as described by E. Poti. Initially, the chief obstacle was that the base oil in the lubricant also had a definite effect on the intensity of infrared radiation. However, it was found that the additive could be removed by volatilization at about 280 F. The infrared radiation of the base oil was then determined, and this effect subtracted from that due to the base oil plus additive.

### Trace Elements in Fuel Oils

A new spectrographic method of determining minute concentrations of metallic elements in residual fuel oils has been developed by C. W. Key and G. D. Hoggan, Richfield Oil Corporation. It quickly and accurately determines sodium, vanadium, nickel, and calcium in concentrations as low as a few parts per million or less. A graphite-disc electrode, rotating through the sample to be analyzed, introduces a film of oil into a high-voltage electrical discharge in the spectrograph. The light rays from the excited atoms are dispersed to form dark lines on a strip of 35-millimeter film. The metallic elements present in the fuel oil, and their concentrations, can be determined from


VICTOR alloy Studs and Bolts have met the exacting standards of the oil industry for more than 30 years. Victor is accustomed to meeting your requirements of quality, price and delivery. Try VICTOR next time you need any fastening.

*Write for the new, easy to use VICTOR catalog.*

VICTOR PRODUCTS CORP.
2635 W. BELMONT AVE. • CHICAGO 18, ILL.

Save!

for Safe – Certain – Economical Removal and prevention of Boiler Scale, wholly regardless of water or operating conditions.

**SAND-BANUM**

*Pure Colloidal Concentrate*

USE OUNCES ONLY ONCE A WEEK

All active ingredients; a can you can hold in your hand safeguards 1 250-hp rated boiler for 1 month.

Guaranteed Harmless to Personnel and Equipment. See us at

Booth 53
International Petroleum Exposition
Tulsa, Okla.

AMERICAN SAND BANUM CO.
Established 1926
9 Rockefeller Plaza
New York 20, N.Y.

the line positions and intensities.

Besides analytic research, sessions were held on metal deterioration, electrical equipment, corrosion, gasoline volatility, training, and processes. Five outstanding papers presented in these sessions are reprinted in full in this issue starting on page 113.

### Segregated Graphite in Steel

Segregation of graphite appears to be related to localization of plastic strain, stated J. J. Kanter, Crane Company Engineering Laboratories. Graphitization only leads to loss of ductility when the factors determining segregation are active. Inspection for graphitization determination must evaluate ductility loss rather than the mere presence of graphite; randomly distributed graphite is not necessarily hazardous. Susceptibility to graphitization is related to steelmaking practice, and the use of aluminum for deoxidation is more vitally involved. When the hazards of graphite segregation must be avoided at all cost, chromium-molybdenum steels are used.

### Atmospheric Corrosion versus Paint Protection

C. C. Harvey, Ethyl Corporation, considered the economic justification for painting refinery equipment. He concluded that what are needed first are realistic appraisals of painting costs and painting techniques on a plant scale. The dual objectives of protecting equipment and making refineries more attractive can only be accomplished by straightforward analyses. He pointed out also that atmospheric-corrosion data obtained on site at the refinery may provide very valuable information on paint requirements. The value of the decorative function of coatings for betterment of the oil industry should be recognized.

### Inhibitor for Refinery Corrosion

A specific organic corrosion inhibitor was described by C. C. Hulbert and J. A. Rippetoe, The Pure Oil Company, which proved effective over a two-year period in reducing corrosion in the tower tops and overhead systems of two primary crude-fractionating units to the extent of 20 to 60 percent in terms of equipment life. Marked improvement in cleanliness and consequent reduction in

Radioactivity
and the
PETROLEUM
INDUSTRY...
is the title of a new Tracerlab pamphlet that surveys most of the known applications of radioactivity in the oil industry. The booklet has been prepared in the belief that such a brief but detailed survey will prove a stimulus to present users to develop new applications, and present a challenge to those firms not now utilizing the unique properties of radioisotopes. A valuable, three page bibliography is included.
Just a word about Tracerlab. Since its founding in 1946, Tracerlab has developed into the largest integrated company in the nuclear field. We produce the most complete line of instruments and accessories; prepare the largest number of "tagged" radiochemicals; and provide the most comprehensive consulting service available in our field of specialty.
Write on your business letterhead — we'll be glad to send a copy of RADIOACTIVITY . . . and the PETROLEUM INDUSTRY.
Tracerlab®
130 HIGH ST., BOSTON
2795 SAN PABLO AVE., BERKELEY
Los Angeles, Paris,
New York, Houston,
Chicago, Washington

## IN THE FUTURE

| | |
|---|---|
| **MAY 1953** | |
| 11–14 | American Petroleum Institute (Division of Refining, 18th Midyear Meeting), Hotel Commodore, New York. |
| 11–15 | National Fire Protection Association (Annual Meeting), Edgewater Beach Hotel, Chicago. |
| 14–23 | International Petroleum Exposition, (30th Anniversary), Tulsa. |
| 27–29 | Short Course in Gas Technology (Eight Annual), Texas College of Arts and Industries, Kingsville, Texas. |
| 28–29 | Western Petroleum Refiners Association (Regional Meeting), Broadview Hotel, Wichita, Kans. |
| **JUNE** | |
| 2– 3 | American Petroleum Institute (Division of Production, Pacific Coast District Spring Meeting), Hotel Statler, Los Angeles. |
| 7–12 | Society of Automotive Engineers, (Summer Meeting), The Ambassador and Ritz-Carlton, Atlantic City. |
| 15–19 | American Institute of Electrical Engineers (Summer General Meeting), Chalfonte-Haddon Hall, Atlantic City. |
| 18–19 | Western Petroleum Refiners Association (Regional Meeting), Conrad Hilton Hotel, Chicago. |
| 28 to July 2 | Petroleum Equipment Suppliers Association (Annual Meeting), Broadmoor Hotel, Colorado Springs, Colo. |
| 29 to July 3 | American Society for Testing Materials (Annual Meeting), Chalfonte-Haddon Hall, Atlantic City. |
| **JULY** | |
| 22–25 | Silver Bay Conference on Human Relations in Industry, Silver Bay, New York. |
| **SEPT.** | |
| 6–11 | American Chemical Society (124th National Meeting), Conrad Hilton Hotel, Chicago. |
| 13–16 | American Institute of Chemical Engineers, Fairmont and Mark Hopkins Hotels, San Francisco. |
| 16–18 | National Petroleum Association (51st Annual Meeting), The Traymore, Atlantic City. |
| 24–25 | Western Petroleum Refiners Association (Regional Meeting), Henning Hotel, Casper, Wyo. |
| **OCT.** | |
| 22–23 | Western Petroleum Refiners Association (Regional Meeting), Garrett Hotel, El Dorado, Ark. |
| 24 | Natural Gasoline Association of America (Regional Meeting), Blackstone Hotel, Tyler, Texas. |
| **NOV.** | |
| 9–12 | American Petroleum Institute (33rd Annual Meeting), Conrad Hilton Hotel and Palmer House, Chicago. |
| 21 | Natural Gasoline Association of America (Regional Meeting), Herring Hotel, Amarillo, Texas. |

cleaning time for tower trays and condenser and cooler bundles were also achieved.

Cost of the inhibiting chemical was 1.3 mills per barrel of crude processed. Continuous chemical injection into the overhead vapor line from the tower and ammonia injection to maintain gasoline accumulator-water pH in the 7.5- to 8.0-range were required for optimum results. The saving in ammonia cost was 0.3 mills per barrel of crude. The exact formulation of the inhibitor was not disclosed.

## NGAA

Special forums at the 32nd Annual Convention of the Natural Gasoline Association of America, Houston, April 29-30, included two papers on gas analysis utilizing a charcoal bed. Clare Gard, Union Oil Company, presented an extension of the test procedure for close approximation of the iso-butane and heavier content of natural gases. This procedure, developed several years ago, was called the air fractioned test since air was passed through saturated charcoal under closely controlled conditions to fractionate the propane and lighter components from the saturated charcoal. A further modification to the test has recently been developed to reflect the propane and heavier content of gases. This procedure is based on a weight determination of a plastic tube containing charcoal, which is inserted in the gas line. The maximum observed error between the weight test and fractional analysis for the propane and heavier yield was from —6.2 percent to +7.2 percent.

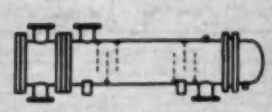
### Heavy Ends in Residue Gas

C. J. Newton, Magnolia Petroleum Company, described an infrared-charcoal adsorption method for determining the heavy ends in a residue gas of the order of 0.01 mol percent. The method adsorbs the hydrocarbons from a measured volume of gas on a charcoal bed. The hydrocarbons are desorbed with a solvent such as carbon tetrachloride, which has a negligible light absorption in the infrared and a boiling point below that of the lowest constituent to be measured. The hydrocarbons in the solvent with boiling points below that of the solvent are removed by fractional distillation. The concentration of hydrocarbons left in the solvent is determined by measuring the light absorption at 3.38 microns and reading the concentration from a calibration curve.

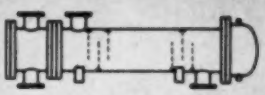
## NPA

Keynoting the 50th semi-annual meeting of National Petroleum Association, Cleveland, April 15-17, P. C. Spencer, Sinclair Oil Corporation, posed the question of how the petroleum industry can continue to create the colossal excess capacity needed for any emergency, while protecting the peacetime industry from being crushed by this threat of excess overhanging the supply side of the market. From government, industry must first obtain a revision and restatement of our anti-trust laws, geared to


**WHITLOCK STANDARD EXCHANGERS**

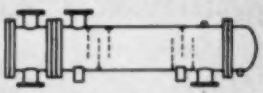


Type SG straight tube, outside packed lantern gland design — eliminates undetected fluid inter-leakage.

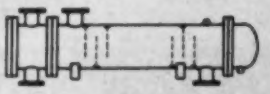


Type ST conventional straight tube, split ring, floating assembly construction.

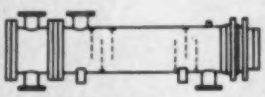
Type R U-tube design — low cost construction, for non-fouling service.



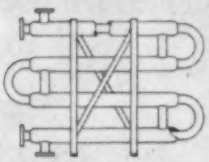
Straight tube, fixed tube sheet design— Types V and V-1 — for easy mechanical cleaning.



Type S pull-through floating head design — for condensing, heating services — for easy maintenance.



Floating head heat exchangers Type SO with outside packed head — no concealed, bolted and gasketed joints.



Double pipe heat exchangers —for counter-temperature flow conditions and low flow rates.

Type C coil type heat exchangers — for high tube side pressures.

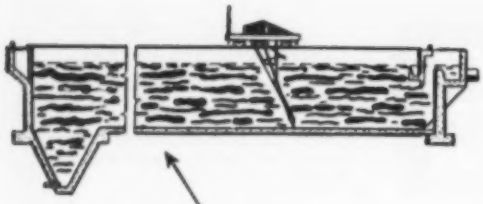
**SAVE WITH "STANDARDS"**

It pays to consider Whitlock Standard Exchangers FIRST. You can make important savings with standard designs:

1. **You save time — "prints for approval" are immediately available for your Engineering Department to use in planning piping and other layouts.**
2. **You save engineering costs — yet you obtain individual engineering attention to assure that the standard design selected is best fitted to your particular needs.**
3. **You save delivery time — units are manufactured from stocked materials and subassemblies. Many completed units are also maintained in stock.**
4. **You save on downtime — duplicate parts are readily available to answer emergency requirements and to reduce downtime.**
5. **You save on first cost — quantity-produced subassemblies and quantity-purchased materials reflect sizeable cost savings: our published price list is tempered by actual production experience. Consult this list and see how Whitlock Standard Exchangers can save you money.**

Whitlock is ready to help you — send for new bulletin describing the complete line of Whitlock Standard Exchangers and outlining dimensions, capacities, and types of services. The Whitlock Manufacturing Co., 75 South St., Hartford 10, Connecticut.

**WHITLOCK**



SHELL OIL
ADOPTS
OIL-WATER SEPARATORS
for
REFINERY WASTES

Overall view of the Hardinge Rectangular Clarifier installation at Shell Oil Company's Houston refinery. The Hardinge traveling mechanism is 41' 6" across and spans two settling sections of the 60' long oil-water separating tank.

The Hardinge Rectangular Clarifier (shown above) is in service in one of the gravity type oil-water separators treating waste water at Shell Oil Company's Houston Refinery. The traveling carriage with attached duplex sediment scrapers is mounted on rails supported by the concrete walls of the separator and extending the length of the settling sections. A flexible electrical cable supported on pulleys supplies current to a one horsepower motor which operates the carriage and assemblies. This clarifier, designed for continuous operation, is controlled automatically, requiring the attention of the operator only in starting and stopping as may be desired.

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA—240 Arch St. Main Office and Works

NEW YORK 17 • SAN FRANCISCO 11 • CHICAGO 6 • HIBBING, MINN. • TORONTO 1
122 E. 42nd St. 24 California St. 205 W. Wacker Dr. 2016 First Ave. 200 Bay St.




modern-day realities for both government and business. Second, our foreign policy must be revised with respect to the oil activities of its nationals in foreign lands, particularly in the Western Hemisphere where the economic and military security of our neighbors is so closely tied to our own.

**Shifts in Petroleum Transportation**

John Boice, PAD, brought petroleum transportation statistics up-to-date, showing that pipe lines over the years have proved to be the mode of transportation best adapted to the movement of crude from wells to refineries. Of the crude oil moved to refineries in 1951, pipe lines delivered 74 percent, water carriers 24½ percent, and tank cars combined only 1½ percent.

Volumetric movement of refined products during 1951, on the other hand, scaled this way: water carriers, 43.5 percent; trucks, 32.8 percent; pipe lines, 13.7 percent, and tank cars, 10 percent. This relationship, however, may be expected to change in the future if expansion of products pipe lines continues at the postwar rate.

## WPRA Group Schedules Tour of Modernized Vickers Refinery

The Western Petroleum Refiners Association will sponsor a Regional Technical-Industrial Relations meeting in Wichita, Kan., May 28-29. Highlight of the program will be an afternoon inspection tour of the modernized Vickers Petroleum Company refinery at Potwin, Kan. Guests will have an opportunity to see the new Thermofor Catalytic Cracking Packaged Unit (PETROLEUM REFINER, March, 1953) which was recently put on stream.

A paper describing the construction and operating experience to date will be given before the tour.

Another paper scheduled for presentation is "Development of Residuum Coking," to be given by J. H. Eppard, process engineer, Blaw-Knox Construction Company. Co-authors are W. F. Simms and F. D. Parker.

Industrial relations speakers include: C. L. Stinnett, assistant personnel director, Lion Oil Company; Jack Tharpe, industrial relations superintendent, Stanolind Oil & Gas Company; and W. E. Blazier, personnel director, Beech Aircraft Corporation.

All sessions will be held in the English Room of the Broadview Hotel.

## ASME Sets Houston Meeting

The annual conference of the Petroleum Division of the American Society of Mechanical Engineers will be held at the Rice Hotel, Houston, September 27-30.

Tentatively scheduled papers for the program include: "Cast Iron in the Refinery," W. J. Buxton, Standard Oil Company; "Monel Protection for Off-Shore Structures," T. P. May, International Nickel Company; and "Why Pre-Stressed Concrete in the Refinery," A. C. Bidwell, Esso Standard Oil Company.

# [ What Suppliers Are Doing ]

**Airplane view of The Davison Chemical Corporation's new plant near Lake Charles, La., with annual rated capacity of 45 million pounds of synthetic fluid petroleum cracking catalyst, opened formally on April 28. Left is the administration building and laboratories; immediately below, the change house and parking lot. Right of the administration building is seen the maintenance building, and below it the main process building, with spray dryers for the production of the microspheroidal type of catalyst visible through the steel framework. Right of the main process building is final filtration and drying equipment, then the tall silos which are for product storage. Dark tanks in background are for storage of sodium silicate. Above the water tower with the Davison "D" are seen sand and soda ash storage silos and the sodium silicate manufactuirng building.**

### Louisiana Governor Dedicates Davison Chemical Catalyst Plant

Dedication of The Davison Chemical Corporation's new plant for the production of synthetic petroleum cracking catalyst at Lake Charles, La., was recently made by Governor Robert F. Kennon of Louisiana.

The dedication ceremonies officially opened the $7 million Davison plant, which will supply a large amount of catalyst used in the production of high octane gasoline and petroleum products. The Lake Charles plant is one of the largest in the U. S.

Construction of the plant was begun in February, 1952. It will manufacture 45 million pounds annually of petroleum cracking catalyst.

### Raybestos-Manhattan Board Names Simpson and Thompson to Top Posts

W. S. Simpson was elected vice president in charge of the Raybestos division, and M. A. Thompson appointed assistant comptroller at a recent meeting of the board of directors of Raybestos-Manhattan, Inc. At the same meeting J. H. Merrell, vice president, Western Sales division, was awarded the 50-year service pin of Raybestos-Manhattan.

### G-E Welding Distributor Named

General Electric Company has named Consolidated Welding Supplies, Inc., New Orleans, its welding distributor for the New Orleans-Baton Rouge area. The firm will handle the complete line of G-E welders, electrodes and accessories. It is managed by C. A. Young and W. B. Blackwell, both members of the American Welding Society.

### Bendix Purchases Ultra-Viscoson From Rich-Roth Laboratories

The Ultra-Viscoson, the "dip stick" that automatically and continuously measures, records and controls viscosity, has been sold by its developers, Rich-Roth Laboratories, to Bendix Aviation Corporation.

Rich-Roth Laboratories will continue to be closely associated with the Ultra-Viscoson as technical consultants to Bendix. The instrument is the first of a line of process control instruments to be produced by the Cincinnati division of Bendix.

### American Cyanamid Makes Change

Name of the Petroleum Chemicals department, Industrial Chemicals Division,


ARCCO

SEE THESE

ARCCO PRODUCTS

at the

OIL SHOW

Booth 179-180 Oklahoma Building

May 14-23

LIQUID GRAVITOMETERS

Recording Liquid
Indicating Transmitting
Indicating Controlling
Recording Transmitting
Recording Controlling

GAS GRAVITOMETERS

Recording – Transmitting – Controlling

LABORATORY GAS BALANCE

PORTABLE GAS BALANCE

CHARTS, CHART DRIVES AND PENS

Booth 179-180 Oklahoma Building

American Cyanamid Company, has been changed to Refinery Chemicals department. No changes have been made in the function of the department.

## Regional Construction Managers Appointed by Johns-Manville

Appointment of six regional construction managers in stategic areas throughout the country has been announced by Johns-Manville Corporation. New appointees are: W. H. G. Murray, New York region, Syracruse, New York; V. D. Suiter, Philadelphia region; James Collins, Cleveland region; H. P. Barnes, St. Louis region; W. F. Quinby, Houston region; and J. B. Jobe, Los Angeles region. G. L. Maw has been named assistant Cleveland region construction manager with headquarters in Detroit.

## Timken Roller Bearing Assigns Morgan, Williams to New Posts

Appointment of Robert G. Morgan to district manager of its Moline, Ill., office and Robert L. Williams to district manager of the St. Thomas, Ontario, office has been announced by the Industrial division of The Timken Roller Bearing Company.

Morgan, who started with Timken in 1937 as an engineering trainee, takes his old post after having served in other capacities in the company.

Williams, who succeeds Morgan in the St. Thomas office, started with the company in 1938 as an engineering trainee. In 1940 he was assigned to the Cleveland office as field engineer. He served three years in the U. S. Navy, leaving the service as a Lieutenant, junior grade.


QUACHROM GLUCOSATE*

The toughest corrosion problems in cooling water systems are readily controlled with Haering's Quachrom Glucosate*. Quachrom Glucosate* is constantly used in the Petroleum Industry to prevent unnecessary shutdowns due to waterside corrosion. Longer equipment life and lower maintenance costs result from Quachrom Glucosate* control. No other corrosion inhibitor can rival the long outstanding record of Quachrom Glucosate*.

Write on your company letterhead for information on Quachrom and other Organic Glucosates. Request special literature on your particular water problem.

* REG. U. S. PAT. OFF

D. W. HAERING & CO., INC.

WATER ANALYSTS . CONSULTANTS . MANUFACTURERS

GENERAL OFFICES

Harlandale Station,

SAN ANTONIO, TEXAS

WE READ WATER H-O-H ESTABLISHED 1931


## Graetz to Manage A. O. Smith Welding Products Division Plant

A. O. Smith Corporation has appointed George M. Graetz manager of the new eastern plant of its Welding Products division, now under construction at Lancaster, Pa.

Graetz

For the past year, Graetz has served as assistant to Group Executive J. J. Bohmrich of A. O. Smith. Most recently he has been acting as project manager in the development of the new plant for manufacture of welding electrodes.

Graetz previously held works manager positions with Trackson Company and Line Material Company. He has also been industrial engineer with American Steel & Wire Company.

At the same time the Welding Products division announced the addition of three new distributors of welding electrodes, welding machines and welding accessories. They are: Pensacola Welding Supply Company, Inc., Pensacola, Fla.; Worland Oxygen Company, Worland, Wyo.; and Guilford Welding Supply Company, Baltimore.

## New Industrial Relations Head Named at American Locomotive

James J. Reynolds, member of the National Labor Relations Board from 1946 through 1951, has been appointed vice president in charge of industrial relations at American Locomotive Company. He had been reappointed by former President Truman to the NLRB in August 1951 for a second five-year term, but he resigned in December 1951. At that time he became vice president in charge of employe relations at United Pipe and Foundry Company. Shortly after that company merged with Sloss-Sheffield Steel and Iron Company last year, he resigned to become a management consultant.

Reynolds will be responsible for all industrial relations activities of the company, including direction of its personnel department, medical and safety operations and other functions dealing with employe relations.

## Ryan Succeeds Deike as President Of Mine Safety Appliances Company

Directors of Mine Safety Appliances Company have elected J. T. Ryan, Jr., president, succeeding George H. Deike, Sr., who was named chairman of the board.

Ryan, son of the man who, with Deike, founded the concern in 1914, began with the company in 1936 as a sales engineer. In 1948 he was elected to the board of directors and named executive vice president. He is president of Callery Chemical Company, Mine Safety subsidiary, and is also a director of the company's subsidiaries in Canada, Scotland and South Africa and other companies.

Deike has been president of Mine Safety since it was founded. He is president and director of Carbon Monoxide

Eliminator Corporation and Catalyst Research Corporation, and holds executive positions in several other organizations.

### Rockwell Names Gilbert Bowman Sales Manager of Two Divisions

Gilbert T. Bowman has been appointed sales manager of both the Nordstrom and Gas Products divisions of Rockwell Manufacturing Company.

Bowman

Joining Rockwell in 1949 as a sales engineer assigned to the Northern California territory, Bowman later directed the sales and service of the San Francisco district office. In August 1941 he was transferred to Pittsburgh as sales manager of Gas Products. The Nordstrom Valve division was put under his jurisdiction when its previous manager, H. Gottwald, was promoted to regional sales manager of the Eastern region.

In his new duties, Bowman will continue to make his headquarters at the Rockwell home office in Pittsburgh.

### Bassett, Jung, Blend and Gibbons Named in Calumet & Hecla Changes

Four executive changes have been announced by Calumet & Hecla, Inc.

Horace Y. Bassett, vice president and general manager of the firm's Wolverine Tube division since 1948, was named vice president of operations. He will transfer from divisional headquarters in Detroit to the new C&H executive offices in Chicago.

C. Chester Jung, recently appointed vice president of finance at a meeting of the directors, has joined the company. Since 1949 he had been president of a Chicago investment counsel.

Don W. Blend was named to succeed Bassett as general manager of the Wolverine Tube division. He joined Calumet & Hecla in 1931 at this location as a draw bench operator. In 1948 he became manager of the division's plant in Decatur, Ala., returning to Detroit early in 1953 as Wolverine's divisional director of operations.

Francis J. Gibbons, secretary and assistant secretary since 1947, was designated comptroller. He joined Calumet & Hecla as a statistician in 1945. He will transfer to Chicago from the firm's corporate office in Boston.

### FMC Gets Controlling Interest In Varley Pumps & Engineering

Food Machinery and Chemical Corporation has acquired controlling interest in Varley Pumps & Engineering Limited, Brentford, Middlesex, England. The English firm produces gear-type pumps used principally for pressure lubrication service, for circulating machine tool coolants and on tank trucks for unloading gasoline.

The transaction, whereby Food Machinery obtained 87 percent ownership of the pump company, was completed at a meeting where FMC was represented by its board chairman, John D. Crummey, and by William de Back,


*Check these advantages of*

# IMPRUVOL 33®
# Gasoline Antioxidant!

✓ **EQUALLY EFFECTIVE IN BOTH MOTOR AND AVIATION GASOLINES,** "Impruvol 33" retards the formation of gum resulting from oxidation.

✓ **WILL NOT CONTRIBUTE TO INDUCTION SYSTEM OR ENGINE DEPOSITS.** In fact, "Impruvol 33" *reduces* engine deposits in actual performance.

✓ **WILL NOT IMPART COLOR TO GASOLINE** since it does not form undesirable color bodies with trace compounds.

✓ **CAN BE ADDED EARLY IN THE REFINING PROCESS** when the gasoline is most susceptible to inhibitor addition. Available in easy-to-use liquid or flake form.

✓ **CANNOT BE EXTRACTED FROM THE GASOLINE** by water, caustic, clay, or the commonly-used pipe line corrosion inhibitors.

✓ **MAY BE USED TO INHIBITOR-SWEETEN SOUR GASOLINE.** Replaces doctor and copper sweetening.

✓ **SAFER TO HANDLE** since it is practically non-toxic and non-irritating.

✓ **MORE ECONOMICAL** on an active-ingredient performance basis than any of the gasoline antioxidants now being used.

***For further information on "Impruvol 33" or DBPC, write:***

**KOPPERS COMPANY, INC.**
**Chemical Division, Dept. PR-53, Pittsburgh 19, Pa.**

KOPPERS® **Koppers Chemicals**

vice president who is resident manager of International Machinery Corporation in Belgium.

Present plans indicate that the operation will continue under its present management.

### Insul-Mastic Names Licensee

Insul-Mastic Corporation of America has appointed S. W. Kooperman, Inc., of Philadelphia as a licensee to handle the sale and application of Insul-Mastic protective coatings in that area.

Kopperman is a well known industrial painting contractor. The company is now prepared to spray the heavy Insul-Mastic coatings on tanks, ducts, vessels, pipes and wherever corrosion may occur.

### Worthington Executive Retires Following 53 Years of Service

William O. Wilson, commercial vice president of Worthington Corporation, has retired after 53 years service with Worthington and its predecessor companies.

Since 1944, Wilson has been responsible for general supervision and direction of all of the firm's commercial activities in the Chicago, St. Louis, Kansas City and St. Paul district office territories.

He began his service with the corporation in 1898 when he joined the Jeanesville Iron Works as a machinist. He subsequently became an erecting engineer and sales manager of the Mid-West district for seven years.

### Clark and MacKendrick Named to Top Posts in Changes at Clark

Important changes in the membership of the board and corporate officers of

Clark MacKendrick

Probst Laverty

Beardsley Moser

Hill

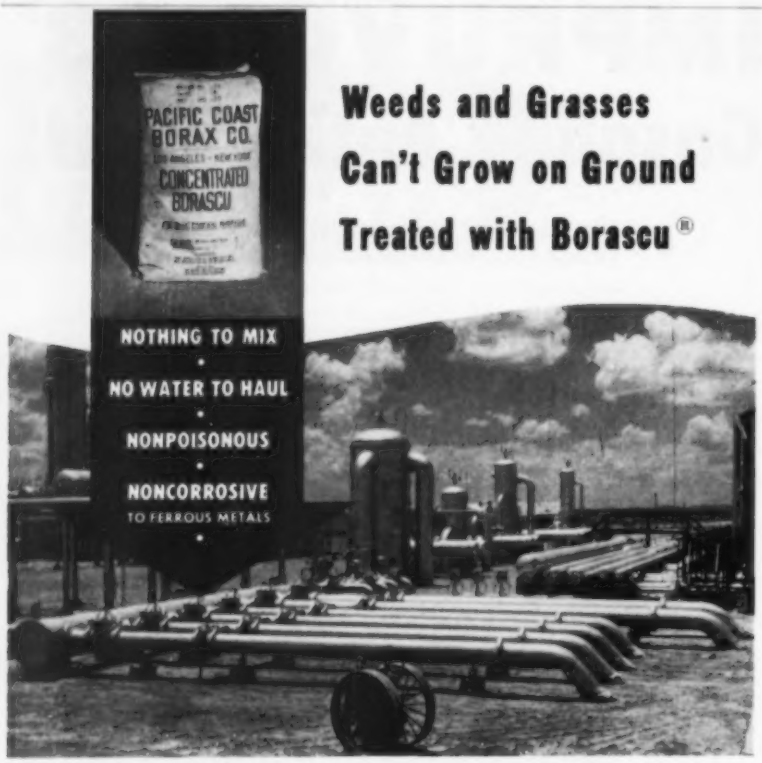
Clark Bros. Company have been announced by its board of directors.

C. Paul Clark, formerly president of the company, has been named chairman. He has been with the company, founded by his father, for 35 years. He began as a chief engineer and later designed a line of engines and compressors for the oil and gas industries. He was appointed president in 1936.

John N. MacKendrick, formerly vice president in charge of engineering, succeeds Clark as president. He joined Clark in 1928 as a design engineer. He has had wide administrative experience with the company.

F. W. Laverty, formerly general sales manager, has been appointed executive vice president. In his 27 years at Clark, he has been variously manager of technical sales, assistant sales manager and general sales manager.

George W. Probst, formerly Western Regional sales manager, has been named


**Weeds and Grasses Can't Grow on Ground Treated with Borascu®**

**.....a single application of Borascu Weed Killer may keep an area cleared for 1 or 2 years!**

Where ground must be kept bare of all fire-hazardous weeds and grasses... that's the place for BORASCU! This weed killer gives long-lasting results because it goes into the soil, and remains there, where it can destroy plant life, *roots included!* Economy-minded production men like BORASCU; figure it saves up to 80% of former "grassing" costs... and it's safe, nonflammable, easy to use. Write for literature.

*DISTRIBUTORS LOCATED THROUGHOUT OIL FIELDS OF U.S.A., CANADA, MEXICO, COLOMBIA, VENEZUELA.*

**PACIFIC COAST BORAX CO.**

DIVISION OF BORAX CONSOLIDATED, LIMITED

630 SHATTO PLACE • LOS ANGELES 5, CALIFORNIA

to succeed David K. Hutchcraft, retired, vice president. Most of his 30 years with Clark have been spent "in the field."

Edward G. Beardsley, formerly chief engineers, has become vice president, engineering; Richard F. Moser, formerly works manager, has taken over as vice president, manufacturing; and C. C. Hill, formerly controller of the company, has been appointed secretary and treasurer.

David K. Hutchcraft, formerly vice president in charge of sales, and Frederic H. Light, formerly vice president, secretary and treasurer, have relinquished their responsibilities in line with the company's retirement policies. They will remain with Clark in a consulting and advisory capacity.

### BS&B Appoints W. M. McGinnis Houston District Sales Manager

W. M. McGinnis has been named Houston district sales manager of Black, Sivalls & Bryson, Inc. He will have supervision of sales and service activities of the Controls and Safety Head division in the Houston sales district.

For the past nine years, McGinnis has been with Black, Sivalls & Bryson as a salesman in the Houston office. He will have offices in the Oil & Gas Building, which is also the oil field sales division headquarters for that area.

### Cooper-Bessemer Promotes Seven To Important Operating Posts

Seven promotions to keep plant operating positions in its Mount Vernon and Grove City, Ohio, plants have been announced by The Cooper-Bessemer Corporation.

Promoted were: Tom McMichan, works manager, and Frank Stevenson, assistant works manager of the Grove City plant, to special assistants to the president at Mount Vernon; Willard Luli, production manager, to works manager at Grove City; Hugh Stevenson, superintendent, to assistant works manager; Ken Martin, assistant production manager, to production manager; Guy Gahagan, assistant superintendent of the day shift, to general superintendent; and Clarence Evans, foreman of the tool room, to shop superintendent, day shift, at Grove City.

### Laclede Arch Appoints Parrick

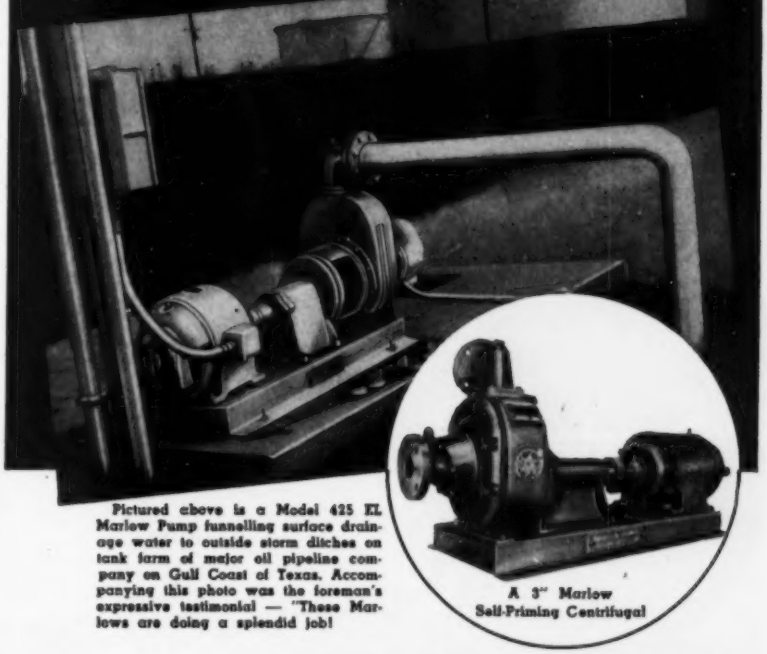
Laclede Arch Company has appointed Francis L. Parrick design engineer. He had been assigned to the company's district sales and engineering office in San Francisco. Parrick was formerly with Alcoa.

### Lummus Company Publishes Booklet Showing Work at Dunkirk Refinery

"Lummus at Dunkirk" is the title of a 16-page brochure just published by The Lummus Company, New York. The booklet covers the company's role in the designing and building of the modern integrated Dunkirk, France, refinery of Societe Generale des Huiles de Petrole, an Anglo-Iranian Oil Company, Ltd., affiliate.

Highlighted is how the new plant was conceived and built in amazingly short time. A running word-and-picture story takes the reader through processing units. Free copies may be obtained by addressing The Lummus Company,


ACTION *proves*



Pictured above is a Model 425 EL Marlow Pump funnelling surface drainage water to outside storm ditches on tank farm of major oil pipeline company on Gulf Coast of Texas. Accompanying this photo was the foreman's expressive testimonial — "These Marlows are doing a splendid job!

A 3" Marlow Self-Priming Centrifugal

**MARLOW PUMPS**

***are specified and PREFERRED for DEPENDABLE performance***

Disposing of surface drainage water in the field and around refineries are only one of many jobs given to Marlow Pumps to do. With the world's largest assortment of sizes and capacities available, veteran oilmen have become accustomed to specifying Marlow Self-Priming Centrifugal Pumps wherever dependable, maintenance-free operation is important. They prime automatically on suction lifts and will not vapor-lock. Marlow installations for handling water or petroleum products are increasingly frequent — and well justified — by their fine operating record and built-in quality construction.

For complete details and engineering solutions to your pumping problems, see your nearest Marlow dealer or write direct for the "Marlow Oil Country Bulletin."

***You're invited to*** — **Booth 94N**

**INTERNATIONAL PETROLEUM EXPOSITION, TULSA, OKLAHOMA**

**MARLOW PUMPS** RIDGEWOOD, NEW JERSEY

Branch Plants: DeQueen, Arkansas; West Chicago, Illinois

Other factories in France and England. Distributors and Dealers everywhere.

266

Room 359, 385 Madison Avenue, New York 17, N. Y.

### Woman Officer Elected at Ethyl

The first woman to be named an officer of Ethyl Corporation since the company was organized nearly 30 years ago is Mrs. Esther Stapley Lyman, who has been elected assistant secretary.

Mrs. Lyman joined Ethyl in 1940 as a secretary in the office of the corporate secretary. She is a member of the Desk and Derrick Club of New York.

### Calumet & Hecla Opens Offices

Sales offices for the Wolverine Tube division of Calumet & Hecla, Inc., have been opened in Columbus. They are located in the High-Long Building.

### Beckman Sales Engineer Given New Post in Company Enlargement

Dr. Elden D. Haller, senior sales engineer with Beckman Instruments, Inc., has been appointed eastern sales manager for the South Pasadena concern.

His selection follows a threefold enlargement of the company's national field force to encourage closer cooperation between user, distributor and producer of Beckman analytical and control equipment.

Headquartered in a new Washington, D. C., office, Haller will supply a direct factory contact for Beckman district representatives and the scientific apparatus and recorder-controller firms which distribute Beckman products east of the Mississippi.

### Two Noted Lift-Truck Engineers Join Clark Equipment Division

John A. Borman and Russell Hastings, two prominent lift-truck engineers,

Borman Hastings

have joined Clark Equipment Company's Industrial Truck division.

Borman worked with Clark from 1946 to 1950 before joining Baker-Raulang Company and has now returned as assistant to Vice President Robert H. Davies on engineering and production problems. Hastings, who spent 18 years with Lewis-Shepard Company, has become assistant to A. O. Williams in directing the activities of the engineering staff.

Borman went to Clark originally after separation from service. In his first tour of duty with Clark, he worked as a welding engineer and a tool engineer. Hastings began work with Lewis-Shepard as a junior engineer in a department which then numbered only four men. After three and one-half years he was elevated to head of the engineering division.

### Four Elected to Executive Posts At Annual Dravo Directors Meeting

Two new vice presidents, a treasurer and a controller were elected at the recent annual organization meeting of the directors of Dravo Corporation.

The vice presidents, both directors of the corporation, are John K. Beidler, general manager of the Machinery division, and Louis P. Struble, Jr., general manager of the Keystone division.

Clifford A. Hill, formerly controller, was elected treasurer, and Edward T. Fitch named controller.

Beidler, with Dravo since 1935, has served in sales and purchasing work with its Machinery division. He was made assistant general manager in 1950, general manager in February, 1952. He was also elected a director in 1952.

Struble began his career with Dravo in 1935 in its Enginering Works division, advancing to general manager of the Keystone division in 1950. He was elected a director in 1951.

Hill became assistant auditor of Dravo in 1939, was elected controller in 1944. He also holds executive offices in other firms.

Fitch joined Dravo in 1928. He became assistant secretary and assistant treasurer in 1942.

### New Officers Elected by PFMA

Officers for the ensuing year were recently elected at the annual meeting of the Propeller Fan Manufacturers' Association held in Dayton Beach, Fla. Elected were: E. C. Englert, president; E. J. Stone, vice president; and L. O. Monroe, secretary-treasurer. Englert is

Refiners! Triangle Brand Copper Sulphate is the right reagent for your oil sweetening process. Triangle Brand Copper Sulphate is available in grades for use in dry form when oil must be partly desulphurized, or for aqueous solutions to remove mercaptans, other sulphur compounds, malodorous and resinous substances from cracked distillates. Use Triangle, it's 99% + pure.

PHELPS DODGE REFINING CORPORATION
40 Wall Street, New York 5, N. Y.
230 North Michigan Avenue, Chicago 1, Illinois

vice president of Hartzell Propeller Fan Company, division of Castle Hills Corporation, and Stone is sales manager of the Propellair division of Robbins & Myers, Inc.

### De Laval Sales Manager Gets New Post in Another Division

De Laval Steam Turbine Company has appointed William J. Healy, sales manager of the De Laval turbine division, to the additional post of sales manager for the blower and compressor division.

Healy

Joining De Laval in 1928, Healy served as a sales engineer for the Turbine Equipment Company, De Laval representative in New England. In 1938 he was transferred to the company's plant sales staff and, by 1950, was advanced to head of turbine sales. Prior to his association with De Laval, he was with Terry Steam Turbine Company for six years.

### Election, Divisional Changes Announced by Babcock & Wilcox

Seven changes in its Refractories division, election of W. H. Rowand as a vice president and appointment of M. Nielsen to head the manufacturing department of its Boiler division have been announced by The Babcock & Wilcox Company.

J. E. Brinckerhoff, formerly sales manager of the Refractories division, has been named general manager of the division.

Other changes in the division: C. L. Norton, Jr., formerly technical director, becomes executive assistant in charge of all sales and manufacturing operation; J. D. McCullough continues as chief engineer in charge of engineering, service and application, with additional duties; Mark J. Terman, formerly district manager of the Pittsburgh office, becomes sales manager; Bradford Hooper, assistant to Norton, becomes technical director; and Royce K. Mack, formerly assistant to Claus, becomes superintendent.

Rowand, the new vice president, will continue as chief engineer of the Boiler division in addition to his new duties. Rowand joined B&W in 1929.

In his new position, Nielsen, recently elected vice president by the board of directors, will be in charge of manufacturing work at the company's seven plants. He joined Babcock and Wilcox in 1924.

### Malone and Wilkinson Shifted In Oil Well Supply Appointments

Two appointments in the California area by the Oil Well Supply division of United States Steel Corporation have made Rex Malone district representative in California and Fred L. Wilkinson manager of the Long Beach, Calif., store.

Malone, former manager of the Long Beach branch, joined "Oilwell" in July 1923 and has since served in various ca-

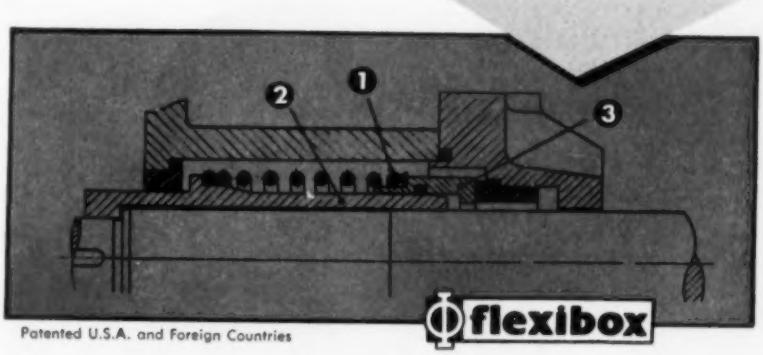

# Announcement

**SEALOL named exclusive representative in the United States and Canada for FLEXIBOX mechanical seals for process pumps . . .**

Flexibox, long recognized as the leading designer and manufacturer of mechanical seals in England and Europe, has now teamed up with Sealol to bring to American Industry the latest improvements in this field. Flexibox designs have already been field-proven by over 15 years in refinery and chemical service, performing safely, economically, and dependably on pumps throughout the world.

Here is the basic Flexibox design showing the unique spring drive feature which insures long life and efficient sealing under all conditions.

The spring ❶ engages the shaft sleeve ❷ at one end and the neck of the rotary seal ring ❸ at the other with interference fits. In operation the coils tend to "wind up", thus further increasing their grip. Consequently, the rotary seal ring ❸ is driven positively yet resiliently.




Patented U.S.A. and Foreign Countries

Now Sealol's own engineering, manufacturing, and service organizations are ready to help you in applying Flexibox designs to your shaft sealing problems. For further information, write to Sealol Corporation, 45 Willard Avenue, Providence 5, Rhode Island.

Chicago, Cleveland, Los Angeles, Philadelphia, Tulsa

*In Canada:*

Lyman Tube & Bearings, Ltd., Montreal, Toronto, Winnipeg

**SEALOL**

**The Balanced Pressure Seal**

**We Build Only PUMPS — The Finest of their Kind**

APCO TURBINE-TYPE PUMPS

AURORA CENTRIFUGAL PUMPS

For the answer to any pumping problem — large or small—lasting dependability and consistent economy — may we suggest that you get acquainted with PUMPS by Aurora. They have pleased thousands. You, too, will like them.

AURORA Always PUMPS

AURORA PUMP COMPANY

SUBSIDIARY OF THE NEW YORK AIR BRAKE COMPANY

84 LOUCKS STREET, AURORA, ILLINOIS

**DAN SMITH**
23 years' experience in producing Durametallic Packings.

**It pays to specify packing that has been produced by *packing specialists*. A score of men, like Dan, have been with the Durametallic Corporation for periods of 10 - 20 and 25 years. Convincing evidence why Durametallic Flexible Metallic Packings are performing the most dependable sealing jobs in industry.**

The PERFECT SEAL

DURAMETALLIC CORPORATION

KALAMAZOO MICHIGAN


pacities. Wilkinson was employed by the division in September 1946 as field representative.

### Du Pont Names New Sales Manager For Petroleum Chemicals Division

Barry V. Cornwall has been appointed assistant manager of sales for the Eastern district, Petroleum Chemicals division, of E. I. Du Pont de Nemours and Company, Inc. Since 1952 he has been technical assistant to the director of sales in the Petroleum Chemicals division.

Cornwall

Cornwall joined Du Pont in 1929 as a technician in the service laboratory of the Dyestuffs division. He laer became a salesman with the Alcohol division, dealing with industrial solvents and antifreeze. He became assistant sales manager of the alcohol and camphor section in 1947.

### U. S. Rubber Division Announces Two Major Organizational Moves

Dr. Earle S. Ebers has been named director of research and development, and Dr. D. Lorin Schoene has become assistant director of research and development in two major changes in the Naugatuck Chemical division of United States Rubber Company.

Ebers, formerly sales manager of Kralastic and Vibrin resins, replaces M. G. Shepard, retired. He joined U. S. Rubber in 1937 as a research chemist in the company's general laboratories at Passaic, N. J. For nine years he engaged in fundamental and applied research on rubber and plastics. In 1949 he was named to the sales post he leaves for the new assignment.

Schoene was formerly manager of the company's plastics development. He joined the U. S. Rubber in 1939 as a chemist in its general laboratories. Following a tour in the Far East he was appointed in 1942 a research chemist for Naugatuck Chemical.

### Griscom-Russell Appoints Manager Of Advertising, Public Relations

William H. Hunter, long-time employe of Griscom-Russell Company, has been named to head the firm's advertising activities. He succeeds James R. Davidson, resigned.

Hunter has had experience in product design as well as in various types of advertising and public relations. In addition to guiding the Griscom-Russell publication advertising program, he will be in charge of preparing bulletins on the company's products and house publication.

### Three Norton Divisions Move Headquarters to New Jersey

The New York domestic sales offices of the Abrasive division, Grinding Machine division and Refractories division of Norton Company have moved to Green and North Street, Teterboro, N. J. They were formerly at 61 Broadway.

Their new headquarters at the Behr-

## Another Interesting VIKING UNIT

**Viking Pumps are leaders in service to the petrochemical industry . . . tops in dependable performance and efficiency.**

Shown here is Viking Model EFH, steel fitted rotary pump mounted on structural steel base and connected through flexible coupling to a Transmission with Micrometer Control and with built in 1800 rpm open type motor delivery output speed from 1550 rpm to 0, installation in a major company research laboratory.

We invite your inquiries.

Distributors

**SOUTHERN ENGINE & PUMP COMPANY**

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

Houston - Dallas - Kilgore - San Antonio - Edinburg - Corpus Christi, Texas. Houma and New Orleans, Louisiana.

## IN WIRE-MESH PRODUCTS LET JELLIFF DO IT!

*For 70 years we've been weaving Wire Mesh. And a good part of that time we have also been making things of Wire Mesh for people who find it is cheaper, easier and generally more satisfactory to "let Jelliff do it."*

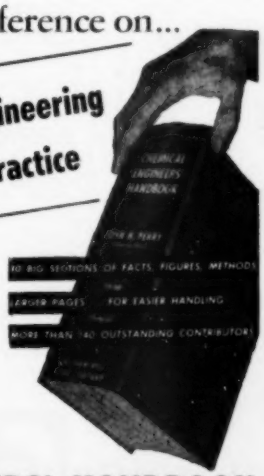
*From big Dipping Baskets to tiny precision filters — from fuel strainers to what-is-it gadgets — JELLIFF'S Custom Production Department turns out fabricated Wire-Mesh products at speed, price and precision that mean lower costs and a stronger competitive position for our many customers.*

*If you buy or make wire-mesh assemblies as components of your own products and have not yet had an estimate from Jelliff, write today for details. No obligation, even if you enclose a blueprint for us to figure on. Address Department 16.*

THE C. O. JELLIFF MFG. CORP.
DIPPING BASKETS · LEKTROMESH · RESISTANCE WIRE
WIRE MESH PARTS · WIRE CLOTH · STRAINERS · FILTERS
SOUTHPORT CONNECTICUT

World's standard reference on...

**Modern chemical engineering fundamentals and practice**


CHEMICAL ENGINEERS' HANDBOOK
10 BIG SECTIONS OF FACTS, FIGURES, METHODS
LARGER PAGES FOR EASIER HANDLING
MORE THAN 140 OUTSTANDING CONTRIBUTORS

THE new 3rd edition of this great standard chemical reference work brings you a fresh and comprehensive coverage of both standard and recently compiled facts, figures and methods related not only to chemical engineering but to important related fields.

The new 3rd Edition

*Perry's*

**CHEMICAL ENGINEERS' HANDBOOK**

*Prepared by a Staff of Specialists,* JOHN H. PERRY, Editor, Technical Investigator, E. I. du Pont de Nemours & Co.

- Fully revised
- Completely up-to-date
- Bigger illustrations
- Thumb-indexed
- 1942 pages, over 2000 illustrations, graphs, tables, $15.00

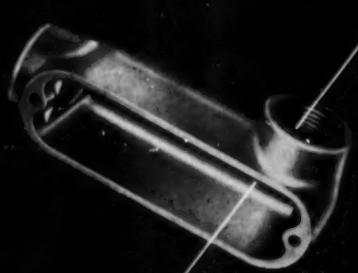
DETAILS of all developments in every branch of chemical engineering—including those of recent critical years—are expertly presented by more than 140 recognized authorities . . . to bring you up to date on currently approved technical data—on new procedures, modern applications, new equipment, etc. Other important information—previously restricted to only a "classified" listing—is made available for the first time. Price $17.00

*"Prices subject to change without notice"*

**THE GULF PUBLISHING COMPANY**

BOX 2608 HOUSTON, TEXAS

## QUALITY CLEAR THROUGH...



SOLID ALUMALLOY CONSTRUCTION FOR A LIFETIME OF CORROSION-PROOF SERVICE

Killark ELECTRIC MANUFACTURING COMPANY

# TRIPLE REASON for installing W. S. ROCKWELL VALVES

*Sizes to 120" for any application.*

**W. S. ROCKWELL COMPANY**

ROCKWELL SINCE 1888 BUILT

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

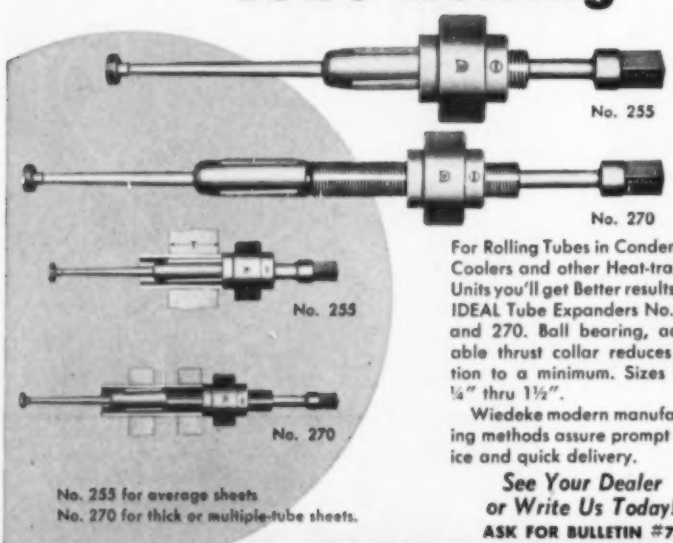
2503 ELIOT STREET • FAIRFIELD, CONN.

*Sales Representatives in Principal Cities*

IDEAL

***Precision-Built for faster, smoother***

# Tube Rolling




No. 255 for average sheets
No. 270 for thick or multiple-tube sheets.

For Rolling Tubes in Condensers, Coolers and other Heat-transfer Units you'll get Better results with IDEAL Tube Expanders No. 255 and 270. Ball bearing, adjustable thrust collar reduces friction to a minimum. Sizes from ¼" thru 1½".

Wiedeke modern manufacturing methods assure prompt service and quick delivery.

*See Your Dealer or Write Us Today!*

ASK FOR BULLETIN #71

THE GUSTAV **WIEDEKE** COMPANY

DAYTON 1, OHIO


Manning warehouse and office have been established to improve service to customers in the New York industrial area.

### Refinery Supply Company Appoints Vanderveld Houston Branch Manager

Appointment of R. W. Vanderveld as its Houston branch manager has been announced by Refinery Supply Company. He will be in charge of the Tulsa firm's warehouse and Houston office.

Vanderveld

Vanderveld was graduated from Michigan State University, Ann Arbor, and majored in chemistry. Prior to joining Refinery Supply Company, he was associated with Central Scientific Company, where he obtained many years experience in handling laboratory apparatus and equipment.

### Lunkenheimer Holds Conference To Review Valve Developments

Distributor sales representatives from five eastern and central states and two Canadian Provinces were guests of The Lunkenheimer Company at a recent two-day conference held in the company's general office building in Cincinnati. Called for the purpose of reviewing new developments by the valve manufacturer, the conference was attended by 36 sales representatives from 14 Lunkenheimer distributors in New York, Pennsylvania, Tennessee, Arkansas and Kentucky, and Quebec and Ontario, Canada.

Tours of Lunkenheimer's large plants highlighted the meeting. Principal emphasis of the gathering was on the use of Lukenheimer guides as sales tools and on the fundamentals of valves.

### Bristol Gets Bigger Facilities

Expansion of its engineering and production facilities for printing recorder charts for instrument companies has been completed by The Bristol Company. The expansion enables the company to produce circular charts up to 18 inches in diameter. Strip charts up to 29⅝ inches wide can now be produced to the company's specification for all types of special instruments. Bristol has also expanded its engineering service.


**GUNITE** Since 1915 CONCRETE SAND AND CEMENT "Placed by Air"

**38 YEARS OF EXPERIENCE PLUS— Hundreds of nationally known clients is evidence of our engineering and construction ability to produce "Gunite" concrete construction at a lower overall cost.**

*Send for specifications and bulletins— no obligation.*

See our catalog in Sweets

GUNITE CONCRETE & CONST. CO.

ENGINEERS — CONTRACTORS

1301 WOODSWETHER RD., KANSAS CITY, MO.

CHICAGO — ST. LOUIS — MINNEAPOLIS

DENVER — HOUSTON — NEW ORLEANS

### International Businessman Named Manager of Rockwell Divisions

Rockwell Manufacturing Company has named Albert G. Lindsay, international businessman and former manager of Crosley Corporation's Foreign division, manager of its Export and International divisions. He will make his headquarters at the firm's home offices in Pittsburgh.

Lindsay

Educated in France, Germany and Switzerland, Lindsay has worked in various parts of the world. For the past six years he has been in business for himself as an American manufacturers' representative and exporter-importer with offices in Argentina, Uruguay and Brazil.

### Chase Brass & Copper Appoints New Texas Sales Representative

Payne C. Barzler, Jr., has been named district manager of the newly created Houston sales district of Chase Brass & Copper Company, Inc. Barzler has been Southern Texas sales representative for Chase, a subsidiary of Kennecott Copper Corporation.

The new sales office and branch warehouse has been placed in operation in Houston. Substantial stocks of all types of brass mill products will be carried, together with selected wire mill and miscellaneous products.

Barzler received his mill training at Chase's Cleveland plant and sales experience in the company's Cincinnati district as resident representative.

### Chiksan Names Lang Exclusive Industrial Sales Representative

The Lang Company, steel fabricators and equipment suppliers in Salt Lake City, has been appointed exclusive industrial sales representative for Chiksan Company in Utah and Idaho.

The sale of Chiksan ball-bearing swivel joints and assemblies and other products of Chiksan Company and its Well Equipment Manufacturing Corporation division will be handled by the Oil Equipment division of Lang.

### Allied Chemical & Dye Division Announces Appointment of Keene

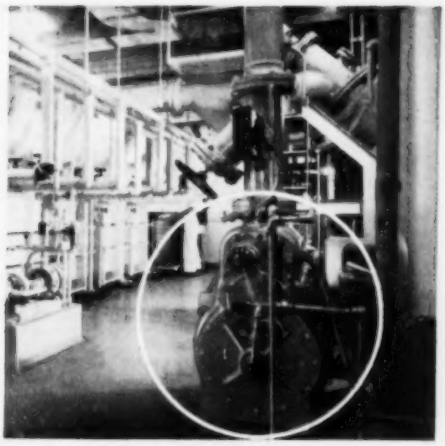
Appointment of Paul A. Keene to assistant to the director of development, Solvay Process division, Allied Chemical & Dye Corporation, has been announced. He will continue to make his headquarters at Syracuse.

Keene has been with Solvay since 1919 and was for several years chief of research. More recently he has been engaged in important technical studies of a research nature.

### Terry Appoints New Denver Agent

The Hank Thurstin Company of Denver has been appointed to handle the sale of The Terry Steam Turbine Company's turbines in Colorado, Wyoming, western Nebraska and northern New Mexico. Hank Thurstin, who has been


IT'S **KINNEY** FOR VACUUM



When petro-chemical processes call for vacuum, it pays to use a Kinney Pump. There's a Kinney Vacuum Pump for every vacuum problem — in research, in pilot plants, or for full-scale production work. Kinney, originator of the oil-sealed mechanical vacuum pump, offers 4 compound pumps (for pressures to 0.2 micron) and 9 single stage pumps (pressures to 10 microns). Write for Bulletin V-51B describing complete line. Kinney Manufacturing Company, 3596 Washington St., Boston 30, Mass. — manufacturers of vacuum and liquid pumps. Representatives throughout the United States and in foreign countries.

SUBSIDIARY OF THE NEW YORK AIR BRAKE CO. Kinney

*See Our Exhibit*
**OIL SHOW**
**TULSA** MAY 14-23

*Send for descriptive bulletin CT-102*

VISIT US AT THE IPE-BOOTHS 46-59 CALIFORNIA BLDG. TULSA-MAY 14-23

**EXCEL-SO**

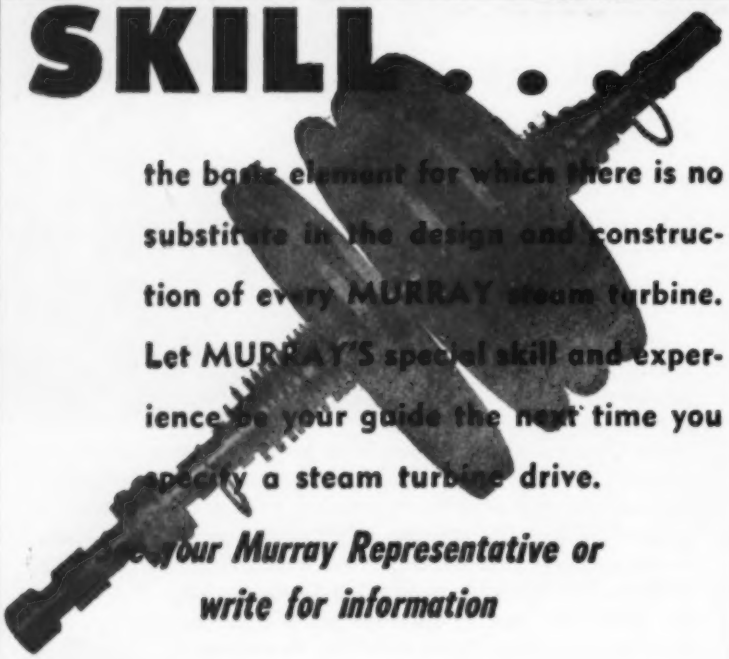
**CALIBRATING TANKS**

*for*

REFINERIES
TERMINALS
PIPE LINES
TANK TRUCKS
LOADING RACKS
PUBLIC SEALERS

We have built hundreds of these provers in all capacities from 50 gallons to 50 barrels. . . . This experience enables us to deliver a REAL PRECISION INSTRUMENT that is Guaranteed. Building, calibrating and guaranteeing a calibrating tank is specialized, painstaking work and is definitely "out" of the price-per-pound category. These tanks are designed to conform to the A.P.I. tentative code #1101, but may be furnished with such modifications as you, the customer, may require.

**WARNER LEWIS COMPANY**
BOX 3096 • TULSA, OKLAHOMA



SKILL . . .

the basic element for which there is no substitute in the design and construction of every MURRAY steam turbine. Let MURRAY'S special skill and experience be your guide the next time you specify a steam turbine drive.

*See your Murray Representative or write for information*

MURRAY IRON WORKS CO.
Burlington, Iowa



For Temperature Control

$35 Nicholson Trap Replaces $200 Unit

Again demonstrating their remarkable effectiveness as a low-cost temperature control, a large processor reports Nicholson expansion steam traps, at about $35 each, are being installed on outdoor tanks and stills in place of temperature controls. These were costing $110.00 to $200.00, with cost of trap added.

The Nicholson traps are readily adjusted to pass condensate at any temperature below 212°F. No air binding. Lengths, 9" to 40". Easily installed, usually without supports. Pressure, 0 to 250 lbs.

For All Equipment Using Steam or Hot Water

| | | |
|---|---|---|
| Dryers | Kettles | Retorts |
| Evaporators | Paper Machinery | Separators |
| Heat Exchangers | Pipe Coils | Steam Stills |
| Heaters | Radiators | Storage Tanks |

CATALOG 751

207 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS


connected with Terry for a number of years, was formerly with Westinghouse Electric Corporation.

### Black Sivalls & Bryson Appoint Lafayette District Sales Manager

Black, Sivalls & Bryson, Inc., has appointed Paul Bartley district sales manager at Lafayette, La. In his new capacity, Bartley has supervision of sales and service activities of the Oilfield Division in the Lafayette sales district.

Bartley

Bartley has been with BS&B for the past 15 years. During that time he has served as branch manager and assistant regional manager.

Bartley's offices are located in the Sonnier Office Building, Room 26, which serves as BS&B headquarters for the Lafayette area.

### Minneapolis-Honeywell Division Adds 25 Engineers to Sales Force

Twenty-five sales engineers have been added to the field sales force of Minneapolis-Honeywell Regulator Company's Industrial division. The new appointees, all recent graduates from the company's industrial instrument training school in Philadelphia, represent a move on the company's part to meet the increased complexities of its industrial marketing problems.

The new salesmen who will be assigned to 20 cities in 16 different states are: John D. Lewis, New York; George H. Negley, East Orange; Thomas L. Mogren, Syracuse; John E. Rattinger, Boston; William H. Hockersmith, Harrisburg; Jack Hopkins, Greenville; Lee H. Nelson, Knoxville; Frank E. Graf, Birmingham; E. A. Spellerberg, Columbus; Joseph H. Toifel and Howard P. Smith, Pittsburgh; and Robert G. Wren, Pat J. Calabrese and William F. Yasdick, Chicago.

Also, Carroll J. Cheslousky and Richard D. Horbinski, Milwaukee; Harold L. Brandt, Des Moines; Robert H. Waggener, Houston; Stanley V. Preskitt, Dallas; Leonard S. Hester, Kansas City; Rodman E. Street, Denver; Robert O. Hutchinson, Portland, Ore.; William T. Lisenby, Los Angeles; and Larkin L. Blake and Theodore G. Lyston, San Francisco.

### Norris, Manufacturer, Announces Field Sales Changes and Additions

A change in and additions to the field sales force of W. C. Norris, Manufacturer, Inc., have been announced.

Dan Coates, formerly with Baash-Ross Tool Company, has joined the firm as sales engineer with headquarters at Abilene, Texas. Doyle Bain, formerly with Wilson Supply Company, has been assigned to the Rio Grande Valley territory in South Texas with headquarters at Corpus Christi. Kenneth Cook, field man at Abilene, has been transferred to the Hydraulic department to devote full time to sales and service of Norris hydraulic long stroke pumping units.

### Bristol Company Names Beane To Executive Sales Position

Harry E. Beane has been appointed vice president of sales of The Bristol Company, Waterbury, Conn. In this position he will continue to make his headquarters at the company's general offices in Waterbury.

Beane

Beane joined the Bristol sales engineering organization in 1920 and, in 1925, was appointed district manager of the company's Birmingham, Ala., office. Five years later he became district manager of the Pittsburgh district.

He was made sales manager of the Instrument division in 1943 and general sales manager in 1947.

### National Aluminate Set to Begin Construction of Catalyst Plant

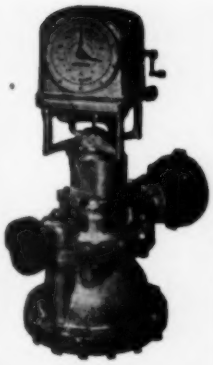
Plans for construction of a new catalyst plant in South Gate, Calif., have been announced by National Aluminate Corporation. The plant, designed for the production of microspheroidal grades of petroleum cracking catalyst, will cost several million dollars.

Construction is scheduled to begin right away, with completion expected by late fall. Full-scale production is anticipated by January 1, 1954. The new installation will supply synthetic fluid cracking catalyst demands of West Coast and adjacent area refiners.

## Company Changes

**Ralph Neuhaus,** general sales manager of the Valve Oil Tool division, **Cameron Iron Works,** has resigned . . . **W. P. Parsons Company,** manufacturers agents, have been appointed representatives in the sale of **American Car and Foundry Company** plug valves in the Boston area and surrounding territory . . . **Dr. Leland M. White,** formerly head of the rubber applications department at **United States Rubber Company,** has been named assistant director of the research and development department. White, who joined the company in 1947, is succeeded in his old position by **Dr. B. C. Barton** . . . **William P. Hemphill** has retired from the board of directors of **Laclede-Christy Company. Herbert F. Boettler,** vice president of the First National Bank in St. Louis, has been elected to succeed him.

**Paul Feeger** has been assigned to the Albuquerque industrial sales engineering staff of **Minneapolis-Honeywell Regulator Company.** Transferred from the firm's Denver office, he will specialize in the sales and service of the company's Industrial and Valve divisions . . . **D. S. Alcorn** has been transferred to the New York offices of **Carbide and Carbon Chemicals Company** to assist with the market development of chemicals being produced at the new coal-hydrogenation plant at Institute, W. Va. He joined the company in 1943, has been a technical representative in the Baltimore District office for the past four years . . .

**COMPLETE Jacketed Pipe and Fluidometer Systems**

***for all liquid-handling problems***

● In any processing operation where the maintenance of a uniform temperature in the process pipes is necessary, a Hetherington & Berner jacketed system will assure dependable, economical production. This is equally true regardless of whether the material being handled requires a hot or cold temperature, what heating or cooling medium is used, or whether the material is corrosive or non-corrosive. Write for Bulletin J-50. If you have a liquid batching problem, involving either light or heavy liquids, jacketed or unjacketed construction, investigate the *Fluidometer System.* This system gives accurate, dependable and *completely automatic* batching and is adaptable to practically any liquid measuring problem, whether it involves gallons, barrels or tank cars. Write for Bulletin Fl-49.

H&B ESTABLISHED 1897

**HETHERINGTON & BERNER INC.**
717 KENTUCKY AVE. INDIANAPOLIS 7, IND.

For your local H & B Distributor see Refinery Catalog Page 587

*EVERY STEP A SAFE STEP* WITH **BLAW-KNOX GRATING**

Everyone walks safely, confidently on Blaw-Knox Electroforged Steel Grating . . . the one-piece panels stay rigid and strong—without shimmy or shake—because there are no parts to work loose. Twisted cross bars provide sure footing under the most adverse conditions. For complete information, write for Bulletin 2365.

**BLAW-KNOX GRATING**
*Industry's first choice for*

• SAFETY • STRENGTH • LONG LIFE
• LOW UPKEEP • SELF-CLEANING

*Grating Department*
BLAW-KNOX EQUIPMENT DIVISION
BLAW-KNOX COMPANY
2005 Farmers Bank Bldg.,
Pittsburgh 22, Pa.

**BLAW-KNOX** ELECTROFORGED STEEL GRATING

"SERV-RITE"

Insulated Thermocouple Wire Extension Lead Wire

FOR

PLATINUM COUPLES
CHROMEL ALUMEL
IRON CONSTANTAN
COPPER CONSTANTAN
IRON CUPRONEL

No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

All Types of Insulation

Felted Asbestos
Asbestos Braid
Weatherproof Braid
Glass Braid
Polyvinyl Plastic
Nylon Braid
Stainless Steel Armored Braid
Silicone Treated
Cotton Braid
Lead Jacket

The home of "SERV-RITE"

Full Particulars on Request

4229

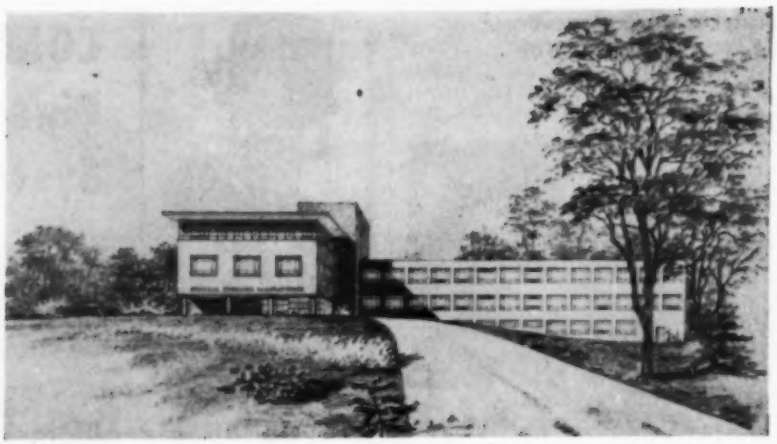
GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines

Dept. 25 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 25 • 2035 Hamilton Ave., Cleveland 14, Ohio



**General Chemical Plans a New Lab in New Jersey—**

**Construction of this large research laboratory at Morristown, N. J., is planned by the General Chemical division, Allied Chemical & Dye Corporation. The new facility will permit General Chemical to expand its laboratory research program and will replace the division's present lab at Laurel Hill, Long Island, N. Y.**

**Plans for the new research center call for a functional three-story brick building, which will have 50,000 square feet of floor space and be complete with the latest types of physical equipment, including electron miscroscope and infrared spectrographs and library. An expenditure of about $2 million is expected.**

**Paul R. Loughin,** recently named executive assistant to **The Babcock & Wilcox Company,** has been transferred to the Boiler division in New York. He had been chief of staff engineering for B&W. **The Marley Company,** Kansas City, has moved its Houston office under **Roy W. Maze,** Gulf Coast manager, to Suite 1601, Commerce Building.

NATIONAL AIROIL
FUEL OIL - GAS
BURNERS

SERVING INDUSTRY FOR 41 YEARS

- Steam Atomizing Oil Burners
- Mechanical Atomizing Oil Burners
- Low Air Pressure Oil Burners
- Rotary Oil Burners
- Industrial Gas Burners
- Combination Gas and Oil Burners
- Tandem Block Combustion Units
- Fuel Oil Pump Sets
- Refractory Burner and Muffle Blocks
- Valves, Strainers, Furnace Windows

Detailed information gladly sent you upon request.

Established 1917 — Incorporated 1917

NATIONAL AIROIL BURNER COMPANY, INC.

1254 East Sedgley Ave., Philadelphia 34, Pa.

Southwestern Division: 2512 So. Blvd., Houston 6, Tex.

## REFINER CLASSIFIED

### HELP WANTED

• PETROLEUM CHEMIST, Ph.D. Org. 5-7 years experience preferably with lube oils or additives to petroleum products. New England. Reply Box 150-R, c/o Petroleum Refiner, Houston, Texas.

### FOR SALE

**For Sale**
**LOCATED IN WEST TEXAS**
**Real Cheap**

1. Braun Bubble Column, 7' x 40' design working pressure, 40 pounds, design temperature, 400° F, approximately 16 bubble trays, vessel insulated. Used as low pressure still in gasoline plant.
2. Braun Bubble Absorber, design working pressure 300 pounds, design temperature 150° F, 5' x 36' x 5/8", contains 18 bubble trays on 18" spacing. Used as an absorber in gasoline plant.
3. Braun Steam Scrubber, 6' x 13', design working pressure 40 pounds, design temperature 200° F. No bubble trays or other internal structure. Used as scrubber for steam to still in gasoline plant.
4. Smith Separator, 3' x 16', design working pressure 500 pounds, no trays or other internals. Used as a copper treater for gasoline.

Box MSK
123 Auditorium Circle
San Antonio, Texas

### ELECTRICAL AND INSTRUMENT ENGINEER

Responsible for the maintenance and installation of electrical equipment and instruments in a complete refinery of an independent oil company located in the southwest. Must have a degree in electrical engineering and at least 5 years experience in a refinery. Will assist Chief Engineer in developing specifications for electrical equipment and instruments. Will supervise the installation and maintenance of same. Salary open subject to experience and qualifications. Box 159-R, c/o Petroleum Refiner, Houston, Texas.

## ESTIMATORS

Young engineers capable of mechanical estimating for construction of refineries, steam power and similar industrial projects. Must have some field experience.

Considerable weight given to ambition, intelligence and interest in estimating and cost analysis.

**BECHTEL CORPORATION**

**220 Bush Street**

**SAN FRANCISCO, CALIFORNIA**

**HELP WANTED**

## CHIEF ENGINEER

Progressive Canadian concern seeks graduate mechanical engineer with at least five years experience in the design of pressure vessels, heat exchangers and bubble trays. Should have a good general knowledge of the equipment for the petroleum and petro-chemical industry.

In applying, furnish a detailed resume of your education, experience, reference and a recent snapshot. Salary open.

Box 157-R, c/o Petroleum Refiner, Houston, Texas.

### LUBE OIL BLENDING AND PACKAGING SUPERVISOR

Responsible for the operations of a modern blending and packaging plant which is a part of a complete refinery of an independent oil company in the southwest. Must have thorough knowledge of drum reconditioning, drum and can filling, box car shipping, and lube oil blending operations. College degree preferred. Salary open subject to experience and qualifications. Box 158-R, c/o Petroleum Refiner, Houston, Texas.

**SITUATIONS WANTED**

■ REGISTERED PROFESSIONAL ENGINEER, young, aggressive, personable. Diversified experience in all phases of refinery operations. Present position: Refinery process engineering department head and assistant to operations superintendent. Desire challenging opportunity with future and chance to utilize abilities in refining, petro-chemical or engineering firm. Box 151-R, c/o Petroleum Refiner, Houston, Texas.

**GLASSES & GASKETS**

**ALL SIZES TO FIT YOUR GAGES & VALVES**
**ERNST WATER COLUMN & GAGE CO.**
***Send for Catalog*, LIVINGSTON, N. J.**

# PETROLEUM REFINER Classified Ads

**RATES:** Regular Classified (undisplayed) set in this size type; 10 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Display ads**, set in suitably larger type with ruled border, $10 per column inch.

**All classified ads payable in advance.** Ten percent discount for two or more insertions of same copy in consecutive issues. COPY DEADLINE: 25th of month preceding date of issue; Send copy and remittance to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

## senior process engineer

Permanent, challenging position on our process staff for a Chemical Engineering graduate with 8 to 10 years experience in petroleum or petrochemical fields.

Our organization has an international reputation and is located on the East Coast.

This man must have the capacity to assume responsibility for process design and development and the potential to supervise other process engineers.

Our salary offer is high, and in addition, we have a liberal pension plan, accumulative vacation policy, and other employee benefits. We will pay for your traveling and moving expenses.

Please write details of your experience and education, salaries received and include your initial salary requirements. Complete privacy is assured since our personnel have been advised of this opening.

**Box 149, RM. 1201**
**230 W. 41 St., N. Y. 36**

## TECHNICAL EDITOR

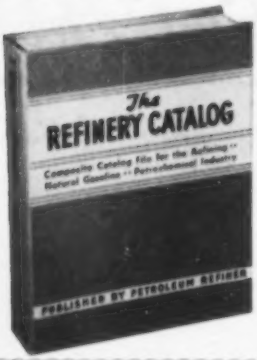
One of this country's oldest technical publications, specialized for the oil and chemical industries, is expanding its staff. Applicant must hold a B. S. degree in chemical engineering. Should have at least two years experience in petrochemical plants. Editing experience not necessary. **THIS IS A MOST UNUSUAL OPPORTUNITY FROM THE STANDPOINT OF SALARY AND CHANCE FOR PROMOTION.** New editor will be located in Houston, Texas. Mail complete details in first letter to,

**BOX 155-R, PETROLEUM REFINER**

■ PETROLEUM CHEMIST. Ph.D. Org. 5-7 years experience preferably with lube oils or additives to petroleum products. New England. Reply Box 150-R, c/o Petroleum Refiner, Houston, Texas.

■ Chemical Engineer: Seven years refinery technical service experience. Desires operating or technical position in Rocky Mountain or West Coast Area. Box 156-R, c/o Petroleum Refiner, Houston, Texas.

# [ Advertisers in the May Issue ]




## They're in The Refinery Catalog

*** The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1953 Refinery Catalog.**


**A**

*The Air Preheater Corp. ..... 25
*Aircool Manufacturing Co. ..... IV Cover
Albina Engine & Machine Works, Inc. ..... 256
Allied Chemical & Dye Corp. ..... 63
*Allis-Chalmers Manufacturing Co. ..... 38-39, 41
*Alloy Steel Products Co. ..... 4
*Aluminum Company of America ..... 188-189
American Cyanamid Co. ..... 74
*American District Steam Co. ..... 50
*American Locomotive Co. ..... 102-103, 211
*American Recording Chart Co. ..... 271
American Sand-Bunum Co. ..... 267
American Steel & Wire Division
United States Steel Corp. ..... 26-27
*The Annin Company ..... 43
*Attapulgus Minerals & Chemicals Corp. ..... 46
*Aurora Pump Co. ..... 278

**B**

*The Babcock & Wilcox Co.
Tubular Products Div. ..... 207
*Badger Manufacturing Co. ..... 240, 261
*Barco Manufacturing Co. ..... 250
The J. B. Beaird Co. ..... Insert 112-113
Bethlehem Steel Co. ..... 251
W. H. & L. D. Betz ..... 249
*Bigelow-Liptak Corp. ..... 70
*Black, Sivalls & Bryson, Inc. ..... 237
*Blaw-Knox Co. ..... 24, 216, 283
*Bridgeport Brass Co. ..... 247
The Bristol Co. ..... 16
*The Brown Fintube Co. ..... 236
Bucyrus-Erie Co. ..... 235

**C**

*Calumet & Hecla, Inc. ..... 56
The Chapman Valve Manufacturing Co. ..... 244
Chase Brass & Copper Co. ..... 191
Chemical Construction Corp. ..... 64
Chicago Bridge & Iron Co. ..... 72
Cities Service Co. ..... Opp. 65
*Clark Bros. Co. ..... 12-13
Clark Equipment Co. ..... 245
The Clark Manufacturing Co. ..... 198
Classified Ads ..... 285
Columbia-Geneva Steel Division
United States Steel Corp. ..... 26-27, 232
*Consolidated Chemical Industries Inc. ..... 106
*Corning Glass Works ..... 217
*Crane Company ..... 185
*Croll-Reynolds Co. ..... 260
*Crouse-Hinds Co. ..... 62

**D**

Davis Engineering Corp. ..... 234
The Davison Chemical Corp. ..... 242-243
*Dean Brothers Pumps Inc. ..... 263
*Dean Hill Pump Co. ..... 65
De Laval Steam Turbine Co. ..... 47
Dempster Brothers, Inc. ..... 49
John Dollinger, Jr., Inc. ..... 266
*Dresser Industries, Inc. ..... Insert 96-97, 230
*Dresser Operations, Inc. ..... 12-13
E. F. Drew & Company, Inc. ..... 265
E. I. du Pont de
Nemours & Co. ..... 33, 90, Insert 224-225
*The Duraloy Co. ..... 265
*Durametallic Corp. ..... 278

**E**

*Elliott Company ..... 23, 92, 241
The Elwell-Parker Electric Co. ..... Opp. 96
Ethyl Corp. ..... Insert 16-17

**F**

Filtrol Corp. ..... Opp. 97
*Fisher Governor Co. ..... 14
*Flexitallic Gasket Co. ..... 104
*Floridin Co. ..... 190
*The Fluor Corp. ..... 199
*Food Machinery & Chemical Corp. ..... 29
*Forty-Eight Insulations, Inc. ..... 200
The Foxboro Co. ..... 60-61

**G**

*The Garlock Packing Co. ..... 87
*Gasoline Plant Construction Corp. ..... 78
Claud S. Gordon Co. ..... 284
Graver Tank & Mfg. Co. ..... 208
A. P. Green Fire Brick Co. ..... 75
*Grinnell Company, Inc. ..... 67
*Griscom-Russell Co. ..... 42
Gunite Concrete and Construction Co. ..... 280
Gulf Publishing Company ..... 279

**H**

D. W. Haering & Co., Inc. ..... 272
*Hammel-Dahl Co. ..... 17
Hardinge Company, Inc. ..... 270
*Hetherington & Berner Inc. ..... 283
Hills-McCanna Co. ..... 218
*Hudson Engineering Corp. ..... 203
Hydrocarbon Research, Inc. ..... 112

**I**

*Ingersoll-Rand Co. ..... 18
*Insul-Mastic Corporation of America ..... 9
*International Engineering, Inc. ..... 206
The International Nickel Co. ..... 20, 287

**J**

*The C. O. Jelliff Mfg. Co. ..... 279
*Jerguson Gage & Valve Co. ..... 221

**K**

*Keasbey & Mattison Co. ..... 110
*The M. W. Kellogg Co. ..... 73,
Insert 32-33, Insert 256-257
The C. M. Kemp Manufacturing Co. ..... 82
*Killark Electric Mfg. Co. ..... 279
Kinney Manufacturing Co. ..... 281
*Koch Engineering Co. ..... III Cover
Kold-Hold Manufacturing Co. ..... 214
Koppers Co. ..... 273

**L**

*Ladish Company ..... Opp. 64
Layne & Bowler, Inc. ..... 101
Leeds & Northrup Co. ..... 8
Warner Lewis Co. ..... 281
Lukens Steel Co. ..... 66
*The Lummus Co. ..... 53, 255

**M**

Maintenance Engineering Corp. ..... 15
Manning, Maxwell & Moore, Inc. ..... 48
Marlow Pumps ..... 275
*The Mason-Neilan Co. ..... 98-99
The Master Electric Co. ..... 58
*Arthur G. McKee & Co. ..... 213
*Metal Goods Corp. ..... 40
*Metal Textile Corp. ..... 94
*Milton Roy Co. ..... 54
*Mine Safety Appliances Co. ..... 264
Minneapolis-Honeywell Regulator Co. ..... 36-37
*Mixing Equipment Co. ..... 88
Samuel Moore & Co. ..... 260
*Murray Iron Works Co. ..... 282

**N**

*National Airoil Burner Co. ..... 284
National Aluminate Corp. ..... 223
*National Foam System Inc. ..... 69
National Tube Division
United States Steel Corp. ..... 26127, 232
*W. H. Nicholson & Co. ..... 282
*W. C. Norris, Manufacturer, Inc. ..... 108
Norton Co. ..... 28

**O**

*Oakite Products, Inc. ..... 262
*The Ohio Steel Foundry Co. ..... 202
*Oil Well Supply Division
United States Steel Corp. ..... 5
Okadee Company ..... 254
*Orbit Valve Co. ..... 86

**P**

Pacific Coast Borax Co. ..... 274
*Peerless Pump Division
Food Machinery & Chemical Corp. ..... 29
Pennsylvania Flexible Metallic
Tubing Co. ..... 59
*Petro-Chem Development Co. ..... 201
*Petroleum Refiner ..... 224
*Petrolite Corp. ..... 83
Phelps Dodge Refining Corp. ..... 276
*Philadelphia Gear Works, Inc. ..... 229
Pittsburgh Lectrodryer Corp. ..... 85
Platecoil Division
Kold-Hold Manufacturing Co. ..... 214
*Porocel Corp. ..... 46
*H. K. Porter Co. ..... 21
*Posey Iron Works, Inc. ..... 68
The Wm. Powell Co. ..... 57
*The Pressed Steel Co. ..... 32
Procon, Inc. ..... 44-45
% Proportioneers, Inc. % ..... II Cover
*Pyrene Manufacturing Co. ..... 246

**R**

*R-S Products Corp. ..... 219
The George Rackle & Sons Co. ..... 266
Reading-Pratt & Cady Division
American Chain & Cable Co. ..... 225
*The Refinery Catalog ..... 51
*The Refinery Engineering Co. ..... 76-77
*Republic Steel Corp. ..... 31, 288
*Revere Copper and Brass Inc. ..... 183
*The Ridge Tool Co. ..... 228
*Rochester Manufacturing Co. ..... 257
W. S. Rockwell Co. ..... 280
*Rockwell Manufacturing Co. ..... Insert 80-81
*Rockwood Sprinkler Co. ..... 227
*Roots-Connersville Blower Corp. ..... 230

**S**

*Sarco Company, Inc. ..... 34
Schapansky and King ..... 264
*Scovill Manufacturing Co. ..... 238
Sealol Corp. ..... 277
*Selas Corporation of America ..... 253
Shell Development Co. ..... 81
The Sherwin-Williams Co. ..... 248
Sims Pump Valve Co. ..... 266
A. O. Smith Corp. ..... 7
Solvay Process Division
Allied Chemical & Dye Corp. ..... 63
Southern Engine & Pump Co. ..... 279
Standard Oil Co. of California ..... 80
*Strong, Carlisle & Hammond Co. ..... 264
*Struthers Wells Corp. ..... 22
*Sun Shipbuilding & Dry Dock Co. ..... 231

**T**

*Taylor Forge & Pipe Works ..... 220
*Taylor Instrument Companies ..... 258-259
Telecomputing Corp. ..... 55
Tennessee Coal & Iron Division
United States Steel Corp. ..... 26-27
*The Terry Steam Turbine Co. ..... 71
Texas Employers Insurance Assoc. ..... 70
The Timken Roller Bearing Co. ..... 6
Tracerlab Inc. ..... 268
Tri-State Manufacturing & Engr. Co. ..... 266
*Tubular Products Division
The Babcock & Wilcox Co. ..... 207

**U**

*United States Rubber Co. ..... 195
United States Steel Corp. ..... 5, 26-27, 232
United States Steel Export Co. ..... 232
United States Steel Supply Division
United States Steel Corp. ..... 26-27
*U. S. Stoneware Co. ..... 35
Universal Oil Products Co. ..... 196-197

**V**

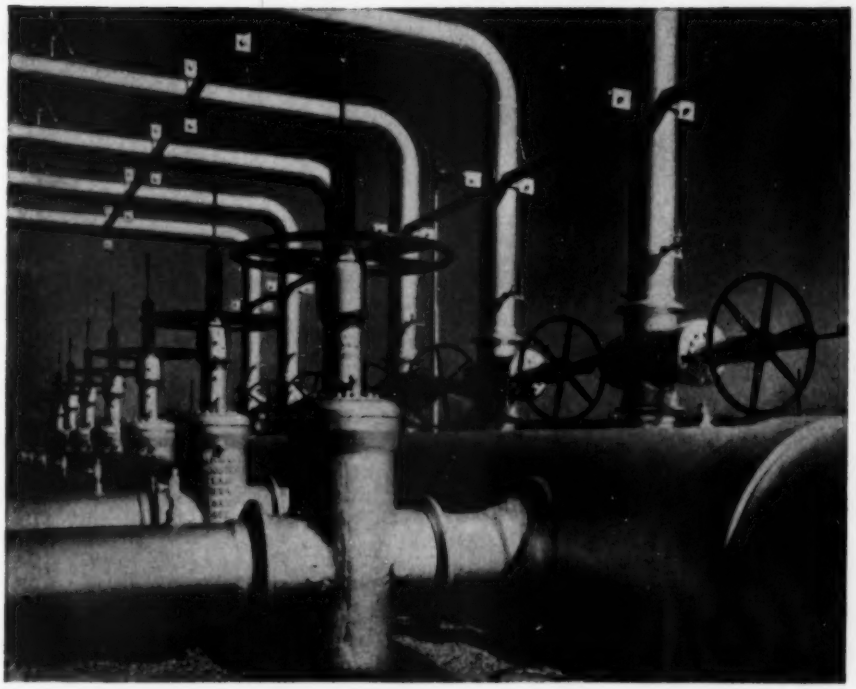
The Van Dorn Iron Works Co. ..... 262
Victor Products Corp. ..... 267
*Henry Vogt Machine Co. ..... 186

**W**

W-K-M Company ..... 215
*Wallace & Tiernan Products, Inc. ..... 252
Walworth Company ..... 52
Warren Petroleum Corp. ..... I Cover
Water Cooling Equipment Co. ..... 239
*Watson-Stillman Fittings Division
H. K. Porter Co., Inc. ..... 21
*Wedgeplug Valve Co. ..... 96
*Weston Electrical Instrument Corp. ..... 226
The Whitlock Manufacturing Co. ..... 269
*The Gustav Wiedeke Co. ..... 280
Williams Gauge Co. ..... 210
Thomas C. Wilson, Inc. ..... 84
*Wolverine Tube Division
Calumet & Hecla, Inc. ..... 56
*Worthington Corp. ..... 10-11
Wyatt Metal & Boiler Works ..... 19

**Y**

*Yarnall-Waring Co. ..... 30



**HASTELLOY ALLOY PROTECTS W-K-M VALVES.** This nickel-base alloy, deposited and finished to a depth of 1/8" on seats and seating surfaces of the gate assembly, is used to control attacks by various corrosives including those encountered in handling oil under high pressure . . . at temperatures up to 1000°F.

# W-K-M Valves coated with Hastelloy Alloy handling flue gas at 800° F

# *Still good after 4 years' service*

Recent inspection of a large refinery's hydroform unit shows:

*Valve surfaces protected by a coating of HASTELLOY nickel-base alloy B are in excellent condition despite 4 years of handling sulphur laden flue-gas passing through a valve orifice under a pressure of 300 pounds per square inch, at 800°F.*

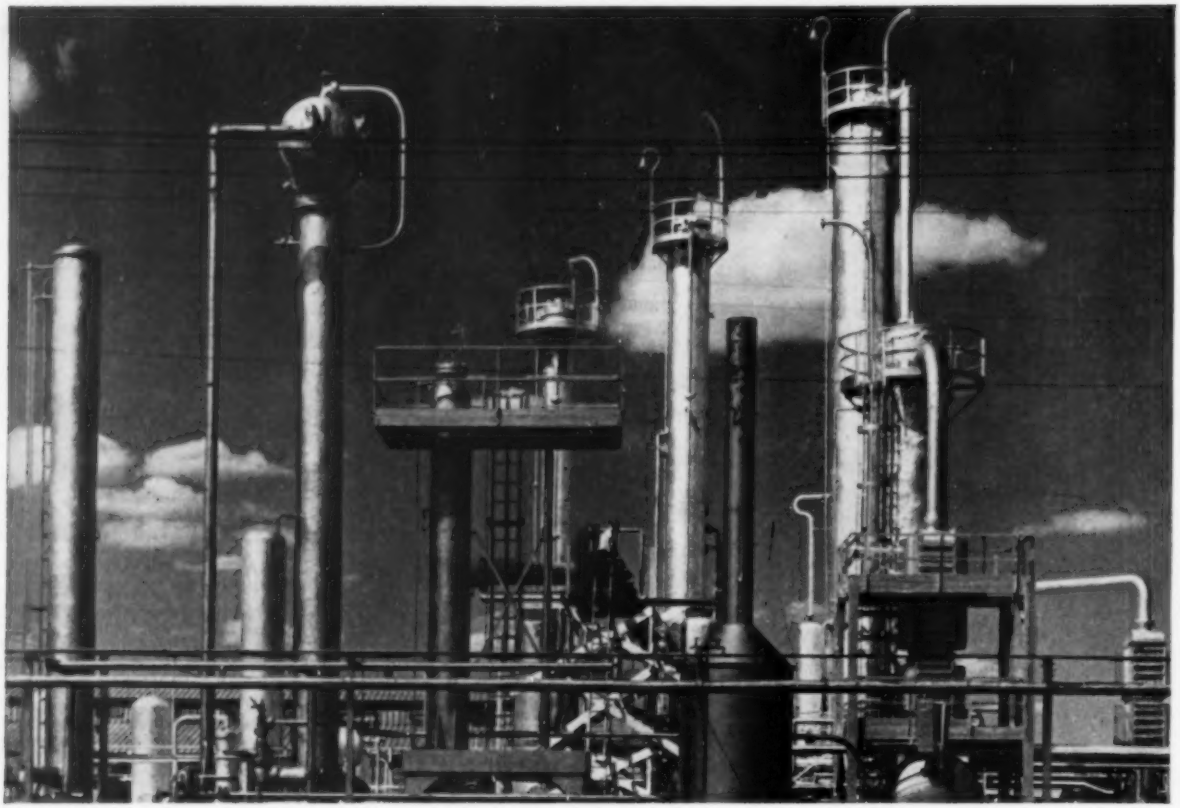
These valves were produced by W-K-M COMPANY of Houston, Texas. Other W-K-M valves, protected by HASTELLOY alloy B, have established exceptional performance records in handling, over long periods, such corrosive media as hydrochloric acid solutions, sulphuric acid solutions, isopropyl alcohol and other agents in chemical and petrochemical processes.

Under your own severe operating conditions, you may find it easy to eliminate trouble and expense by utilizing one of the series of nickel-base alloys trade-marked "HASTELLOY," produced by Haynes Stellite Company, Kokomo, Indiana, a Division of Union Carbide and Carbon Corporation.

**INCO BOOTHS Nos. 64 and 65**

EMBLEM OF INCO SERVICE

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 WALL STREET NEW YORK 5, N. Y.



# ENDURO helps keep "Tower Internals" clean

You're "on stream" longer . . . with a minimum of "down-time". . . when your tower internals are made of Republic ENDURO Stainless Steel. Because ENDURO is so much easier to clean . . . no matter where you use it.

Take bubble caps and trays. Down-time for de-coking can be a big item . . . unless they're made of ENDURO. Then, down-time is at the bare minimum. ENDURO's smooth surface offers little chance for coke to adhere. And even when some does . . . generally after prolonged periods . . . in most cases it can be removed with a stream of water.

Take corrosion. Or rust. Even most alkalies and acids. ENDURO resists them . . . maintains its great strength under prolonged exposure to scorching or sub-zero temperatures. And because its strength to weight ratio is unusually high, ENDURO doesn't buckle or fail under pressure . . . even when you use it in thinner, bulk-saving sections.

These advantages add up to minimum maintenance . . . long equipment life . . . high productivity and increased over-all tower efficiency. If you have plans for modernizing . . . or expanding . . . it will pay you to find out more about ENDURO. Republic metallurgists are ready to work with you on refinery developments involving the use of stainless steels. Just write to:

**REPUBLIC STEEL CORPORATION**
*Alloy Steel Division • Massillon, Ohio*
**GENERAL OFFICES • CLEVELAND 1, OHIO**
Export Department: Chrysler Building, New York 17, N.Y.

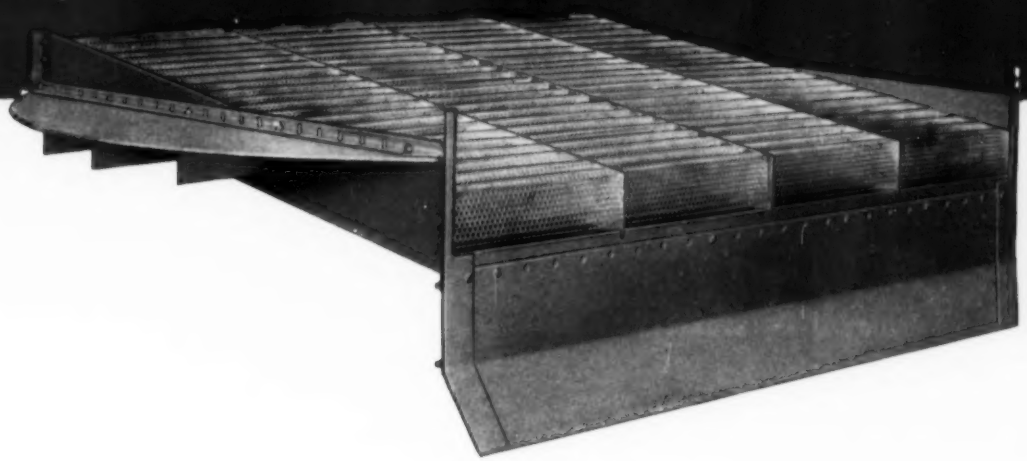
**See and Hear**
**"THE STORY OF STAINLESS"**

Full-color, 16 mm sound film —27 minutes running time. Dramatic . . . historic . . . interesting. Available to qualified groups without charge. Requires 16 mm sound projector. Send name of organization, type of projector, requested date to Ideal Pictures Corp., 65 E So. Water St., Chicago 1, Ill., or write Republic Steel, Dept. K, Cleveland 1, Ohio.

*Republic*
REPUBLIC STEEL
**ENDURO STAINLESS STEEL**

**Other Republic Products include Carbon and Alloy Steels—Pipe, Sheets, Strip, Plates, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing**

# "Extraordinary Performance Is Routine" with KASKADES



**CASE HISTORY No. 1...**

One refiner was operating a 7.5' vacuum tower which was limiting capacity and yields due to the pressure drop of existing bubble trays. Capacity desired was:

Vapor....24,600 #/hr of 0.0137 #/cf density
Liquid.....36,400 #/hr of 58.3 #/cf density

This refiner replaced the bubble trays with "Benturi" Kaskade trays on the same supports, and is now obtaining a pressure drop of less than 1.0 mm hg pressure drop per tray.

**CASE HISTORY No. 2...**

An engineering firm recognized a pressure drop problem with a process duty equivalent to:

Vapor.....35,500 #/hr of 0.26 #/cf density
Liquid.....965,000 #/hr of 62.4 #/cf density

Yet, multi-pass "Benturi" Kaskade trays in a 7.5' diameter column gave them less than 2.0 mm pressure drop per tray.

***Whether your problem is extraordinary or routine, the design flexibility "Benturi" Kaskade tray is probably your answer to greater capacities and higher efficiencies. Wire, write or phone us on its application to your fractionating problem, there's no obligation.***

## KOCH ENGINEERING COMPANY, INC.

DESIGNERS • MANUFACTURERS • BUILDERS

321 WEST DOUGLAS • WICHITA 2, KANSAS

Eastern and Export
30 Rockefeller Plaza
New York City

Pittsburgh, Pa., Repr.
D. D. Foster Co.
412 Peoples Gas Bldg.

Tulsa, Okla., Repr.
Myers-Bagwell Co.
Wright Bldg.

British Associates
Messrs. A. F. Craig & Co., Ltd.
Paisley, Scotland

# "AIRETOOL helps me do my job BETTER

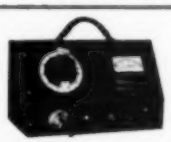
**. . . because Airetool builds tube maintenance equipment right!"**

Airetool tube cleaners, tube expanders and oil refinery specialities are engineered and precision-built to do a better job. They are used throughout the petroleum industry to do an important job—to keep tubular processing equipment at its highest efficiency.

TUBE CLEANERS



TUBE EXPANDERS



TUBE EXPANSION CONTROL

CATALYST REMOVAL SYSTEMS

JOINT CLEANERS

OIL REFINERY SPECIALITIES

**AIRETOOL**

**MANUFACTURING COMPANY**

SPRINGFIELD, OHIO

REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, South America, England.

BRANCH OFFICES: New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge, Hudson Heights (N.J.)

SEE THE COMPLETE AIRETOOL LINE AT THE INTERNATIONAL PETROLEUM EXPOSITION
BOOTH 151 and 152, OKLAHOMA BLDG.